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January-February 1957

METAL TREATING

Published by the Metal Treating Institute

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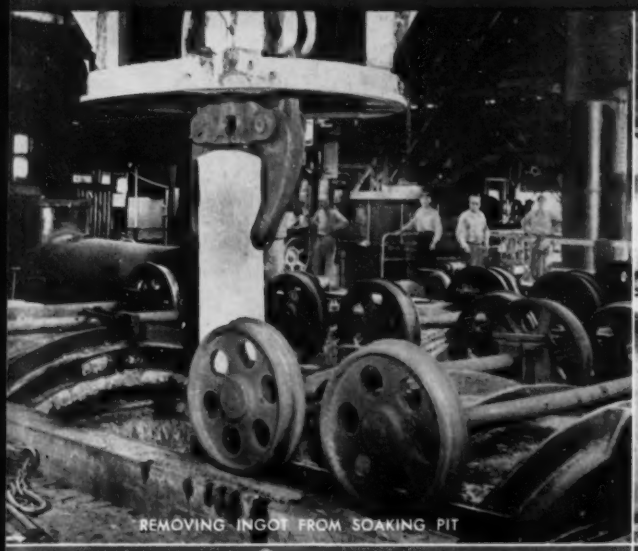

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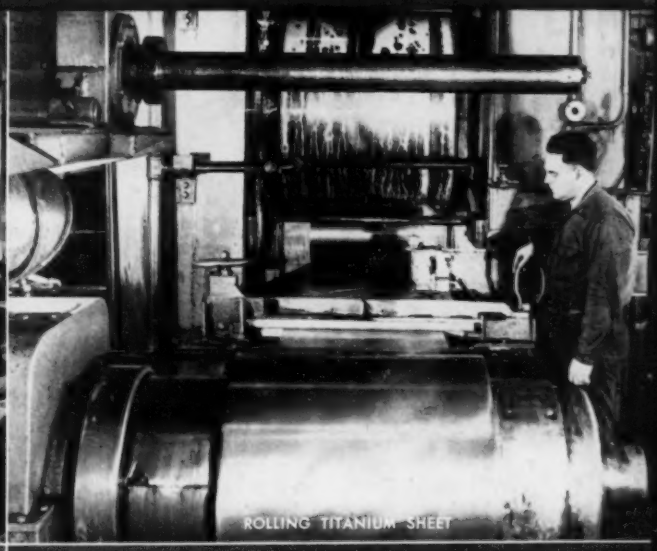

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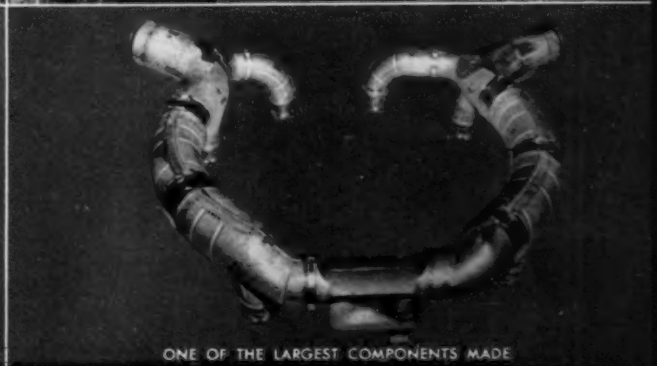

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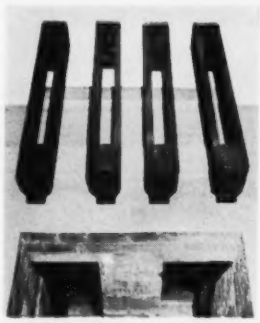

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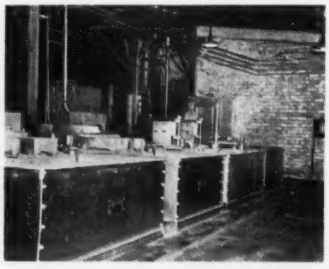

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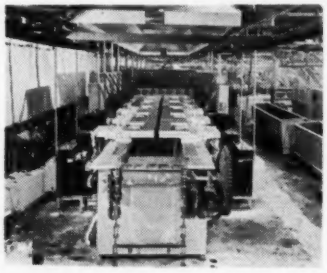

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National Trade Association of Commercial Heat Treaters

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Indexed in Engineering Index

METAL TREATING

EDITORIAL

OFF TO A FLYING START

According to all the "prophets" astrological, economical, phenomenal or otherwise—1955 is going to be a "banner" year. We hope they are 100% right for, of course, if they are, the heat treating industry will be right out in front.

Even before we began reading all these hopeful and happy predictions, we had set our sights to make 1955 a "banner" year for METAL TREATING. Naturally since the conception and birth of our publication our basic goal has been to establish a magazine which is both *helpful* and *interesting* to our readers. That, of course, is, or should be, the goal of all publishers, plus, naturally, making a fair profit.

So—our first issue in 1955 brings you, in addition to our regular features, *three* new departments:

1. "Readers' Service"—to help you get information faster and easier. (*See new cards*)
2. "Apprentice Corner"—to help the young fellows get their feet on the ground. (*See page 12*)
3. "Right or Wrong"—a column for management to guide them through others' experiences in labor relations. (*See page 28*)

We are confident you will like these and hope they *help* you. If they do—our "banner" year is off to a flying start.

C. E. Herington

CONTENTS

FEATURES

How To Avoid Heat Treating Difficulties Through Correct Design of Press Tools *by Federico Strasser* 2

Application of Nitriding to Hot Forging Dies *by Alexander F. Sherys* 14

A Year of Progress—Titanium in 1954 *by T. W. Lippert* 18

Heat Treating Titanium 20

Cooperation Between the Heat Treater and the Steel Manufacturer *by C. B. Post* 24

DEPARTMENTS

The Apprentice Corner 12

Right or Wrong in Labor Relations 28

Institute News 30

News to Heat Treaters 32

Heat Treating Abstracts ... 36

Letters to the Editor 41

Equipment and Materials Directory 42

Manufacturers' Literature .. 43

Advertisers' Index 44

Editor's Note: *This is the first contribution to appear in* METAL TREATING *from a resident of one of our "Good Neighbor," South American countries. Prior to publication, this manuscript was forwarded for comment to Mr. J. Y. Riedel, Tool Steel Engineer for Bethlehem Steel Company and a well-known specialist in tracing the causes of tool failure. Mr. Riedel's reply is published as an addenda to this article. Figs. 51 to 54 were also supplied by Mr. Riedel and the Bethlehem Steel Company as examples of die designs creating difficulty in heat treatment.*

How To Avoid Heat Treating Difficulties Through

CORRECT DESIGN OF PRESS TOOLS

By **FEDERICO STRASSER**
Mankewitz & Strasser, Ltda.
Santiago, Chile

Today we live in an age of specialization. Since every professional activity requires so much specific knowledge from its active members, it is impossible to ask from anyone a universal, thorough skill in the whole field, in every branch of his profession. Even the "expert" must have a more than superficial knowledge about the related activities to his specialty, in order to insure a better performance of the whole organization.

So, the tool engineer, who dedicates himself to die design, must know all about the difficulties and troubles he might cause to the performers of his plans; namely, the toolmaker and the heat treater. It is generally true that the die designer knows enough about toolmaking, but very little about heat treatment. Therefore, a close collaboration between the die designer and a specialist in heat treatment would be very beneficial. Through friendly discussion for a few minutes, many dollars worth of skilled labor and expensive steel can, at times, be saved.

It is the purpose of this contribution to give the die designer some fundamental ideas about the troubles he can give the heat treater and the ways to avoid them.

Failure in a die member (or for that matter any workpiece made from steel) which has been heat treated with the most scrupulous care and in proper equipment may often be traced to either or both of the following: *a.) improper selection of steel grade and b.) incorrect design of the workpiece.* Let us consider each of these factors separately.

Proper Selection of Steel

Every serious tool steel maker produces a lot of different types of steel grades in order to satisfy every possible special requirement. (We also have specialists here.) However, in die making, we can drastically simplify the selection of steel types because more than 90% of all requirements can be covered by three grades: water-hardening, oil-hardening and air-hardening steel. In relative cost, water-hardening steel is cheapest and air-hardening steel is the most expensive.

Water-hardening steel has the greatest tendency to crack in hardening. Consequently, it must be employed only in cases of very simple and regular die members, such as round die plates (with circular die opening), round punches, dowel-pins, and similar pieces.

Oil-hardening steel has greater resistance to cracking and warping as well. Therefore, it is preferred for die plates with somewhat irregularly shaped cutting openings, other than round punches, etc.

Air-hardening steel is to be used where very severe conditions exist, such as great internal stresses or a marked tendency to cracking and warping. Such cases are very complicated cutting figures with sharp variations in shape and size, both in die plates and punches.

Economics is not always the factor which determines the selection of a steel grade. In fact, water-hardening steel has a few features which make it preferable in certain cases. It doesn't harden through, but retains a tough core in sections over ½". Consequently, it has greater flexural strength; it can support greater bending and stamping pressures. It is also easier to machine, so the die members made from it are more quickly done and cost less.

On the other hand, in the case of high production tools where long service is expected, oil-hardening and even air-hardening steels must be chosen, because of their better wear resistance.

What is Good Design

A good design is a *balanced* design, that is, where there is a uniform steel section or at least the changes in cross-section are small and the variation from one section to the other is smooth and sloping. Conversely, in cases of unbalanced design, where heavy sections adjoin thin ones, trouble is unavoidable. On heating an unbalanced workpiece, the lighter sections will heat faster than the heavy ones and, consequently, internal strains develop. The consequences are distortion, warping and in severe cases, cracking.

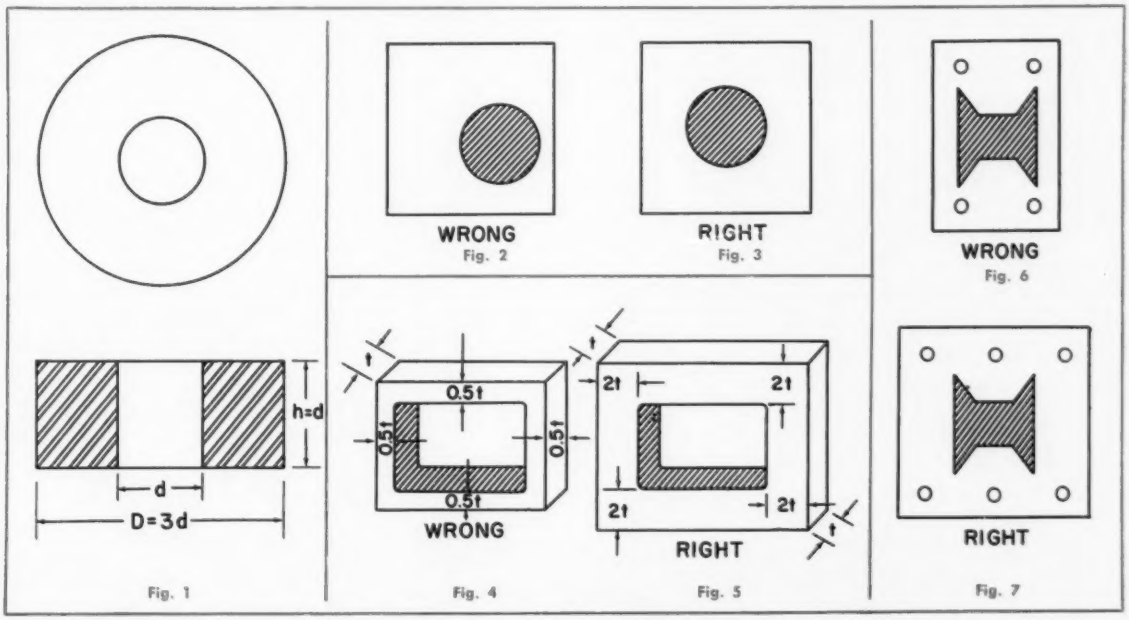

Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7

The ideal design is a sphere, where the cross-section at every point is the same. In the case of dies, the ideal is a round blanking die plate (or drawing die plate) with the proportions indicated in Fig. 1.

Of course, in practice we are called upon to make parts other than simple round dies, and so we are obliged to make some concessions to ideal conditions. Nevertheless, by following the hints given below many troubles and failures can be avoided in the heat treatment of die members.

Fundamental Design Details

1.) Cutting (or drawing) openings must be located in the most concentric way possible, in order to get uniform cross-sections (Figs. 2 and 3).

2.) Leave an ample section of steel around the blanking opening, i.e., between the blanking outline and the next cutting openings or the die plate edge. This section varies with the size and contour of the cutting opening; it is good practice to leave 1½ to 2 times the die plate thickness in small dies and 2 to 3 times the die block thickness in the case of large dies (Figs. 4 and 5). Use the lower values for simple, regular die openings and the higher values for more complicated cutting shapes.

3.) Auxiliary holes (for piercing apertures, alignment dowel-pins, clamping screws, stop-pins, etc.) should not be put in direct line with the projection of cutting lines. This causes easy cracking (Figs. 6 and 7).

4.) Between auxiliary holes and cutting opening edges leave sufficient area which corresponds to at least die plate thickness, or more if possible (Figs. 8 and 9).

5.) Any hole in a die plate corner (auxillary hole for clamping or alignment purposes) must be located so that the minimum distance between its center line and the plate edge is at least 1½ times the hole diameter (Figs. 10 and 11).

6.) Sharp corners and angles must be avoided whenever possible. Add generous fillets to blanking opening corners (Figs. 12 and 13); round all the non-cutting holes in the die plate and the bottom edge of the cutting openings (Figs. 14 and 15). All the corners and outer edges of the die plate should be rounded off whenever practical.

7.) Try to balance section masses. Adjoining large and small sections must be avoided if possible. At least make the passage between them the smoothest possible, with generous filleting. Eliminate absolutely sharp corners (Figs. 16 and 17).

8.) For fastening the die plate, absolute preference must be given to the use of screws which go *through* the die plate without threading and are screwed into the die shoe (Fig. 18). Any other design is to be rejected, such as through-threaded holes (Fig. 19), blind-threaded holes (Fig. 20), filister-head countersunk holes (Fig. 21), etc.

Tricks For The Solution of Design Problems

It is not always possible to comply directly with fundamental design requirements, as outlined above. Sometimes the contour, shape or dimensions of the die openings are such that some of the given rules must be broken. Even in such cases there may be ways by which the goal of perfect design can be reached indirectly.

(*Continued on page 6*)

Eight examples of design errors which create difficulty in heat treatment.

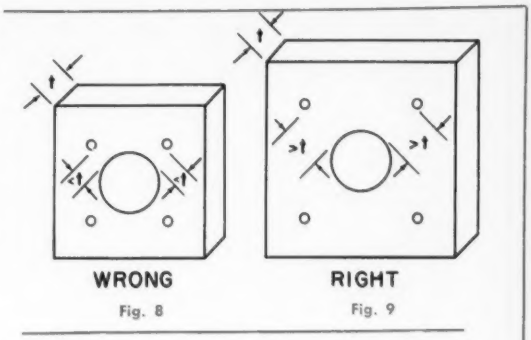

Fig. 8 Fig. 9

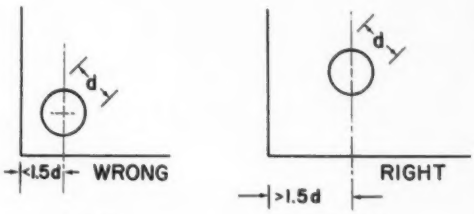

Fig. 10 Fig. 11

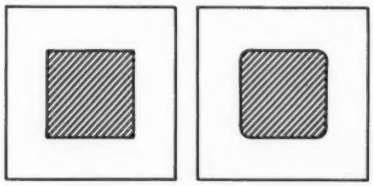

Fig. 12 Fig. 13

Fig. 14

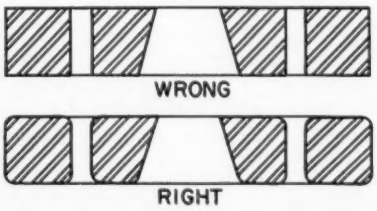

Fig. 15

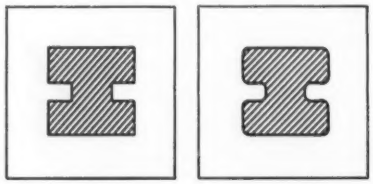

Fig. 16 Fig. 17

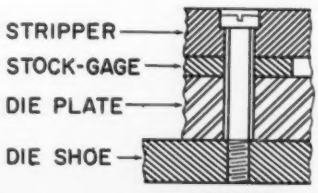

Fig. 18 RIGHT

Fig. 19 Fig. 20 Fig. 21

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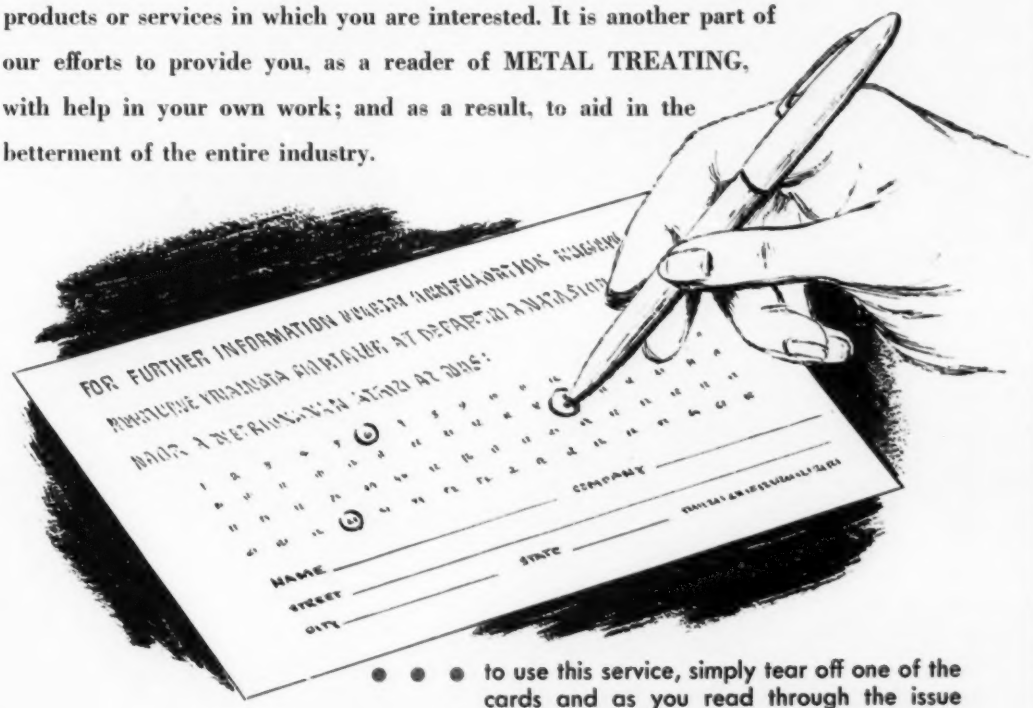

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METAL TREATING **271 North Avenue, New Rochelle, New York**

Four practical solutions for the correction of unfavorable designs to eliminate failure in heat treatment.

Here follow a few practical suggestions.

1.) If the corner of a blanking opening must be made with a sharp angle (see Fig. 12), make the die plate according to Fig. 13 and after heat treatment, grind away the superfluous metal. (Use this method only on oil- or air-hardening steels.)

2). In unbalanced die plates, with heavy and light sections adjoining, to equalize masses and thus aid dissipation of heat, open some additional holes in the heavy portion, thus lightening it (Figs. 22 to 25).*

3.) Unbalanced die plates often may be divided into two or more separate steel blocks, each block having uniform heat treating characteristics.

4.) The first rough draft of a die plate plan is at times such that some secondary cutting or auxiliary hole would be located too near the chief cutting openings, creating a very weak area in the die plate. In such cases the designer should revise the layout, if possible, in order to avoid troubles not only in heat treatment, but also in service. a.) In progressive dies, the solution may consist simply in skipping a station. Instead of having the piercing operation immediately follow the blanking operation, leave an idle intermediate station between the two. (Fig. 27 instead of Fig. 26). b.) When two or more auxiliary piercing holes result too near each other, separate the piercing operations into two or more stations (Fig. 29 instead of Fig. 28.) c.) For too closely situated small holes which must be pierced in second operation dies, the only solution is to perform the operations in separate tools; one (or a group) in each die. As an alternate, the same die may punch the workpiece in two separate operations; by means of a movable rest the workpiece can be presented in different ways to the piercing punch (es) (Fig. 30).

* *See addenda for comments regarding this point.*

(Continued on page 8)

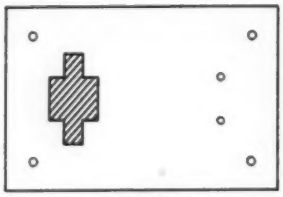

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Fig. 22

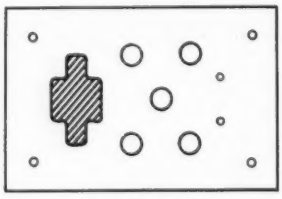

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Fig. 23

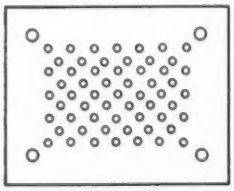

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Fig. 24

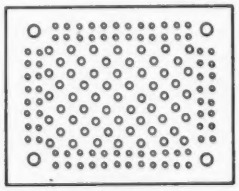

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Fig. 25

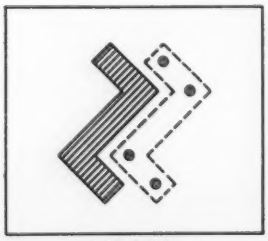

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Fig. 26

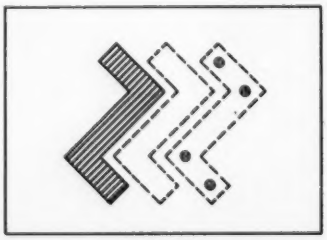

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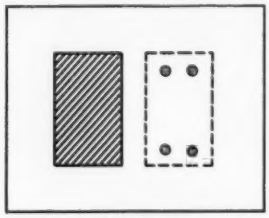
Fig. 27

Fig. 28



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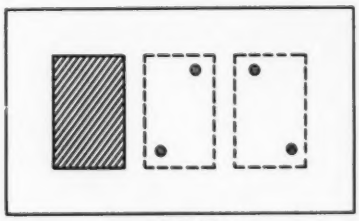

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Fig. 29

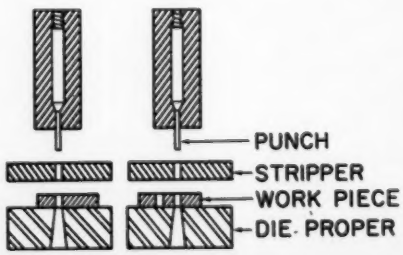

Fig. 30

measuring up

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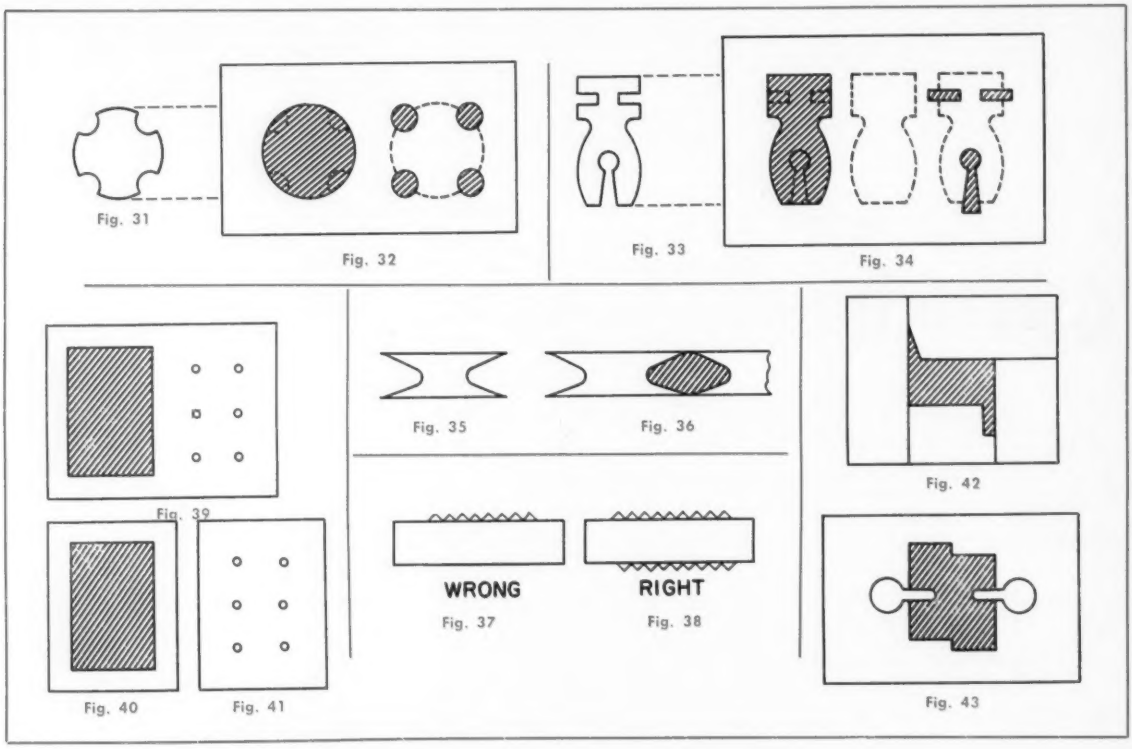
5.) Progressive type dies lend themselves to the easy solution of seemingly difficult, complicated die opening and punch contour problems. For example, the workpiece shown in Fig. 31 can be produced by means of a very simple and inexpensive progressive type die, as presented schematically in Fig. 32. The four small trimmings made in the circular disc are produced with four round piercing punches, which operate in a preliminary station. Figs. 33 and 34 illustrate another example.

6.) Cropping dies (cut-off dies) at times provide the solution for avoiding difficulties in the heat treatment of die members. For example, a workpiece such as Fig. 35, if produced in a standard blanking die, would require a die plate and punch which would cause difficulty in hardening. Changing to a simple cut-off die would eliminate heat treating problems (Fig. 36). The cut-off die is also much more expensive than a corresponding blanking die.

7.) In flattening or rigidizing dies, cut-outs on one face unbalance the mass of the steel block. This can be overcome by using the same design on the bottom surface of the plate, in order to balance the section (Figs. 37 and 38). Another advantage is double life for the die plate.

A change in basic die design can yield economy in manufacture and help the heat treater.



Examples of how sectional dies can be revised to eliminate difficulties in heat treatment.

Sectional Dies

In addition to the universally known and well appreciated advantages gained from sectional construction, this type of design very often also offers an easy means for the solution of the heat treating difficulties.

Here follow a few typical examples:

1.) Progressive dies very frequently have unbalanced die plates. Fig. 39 illustrates a characteristic case. Dividing it into two separate sections (Figs. 40 and 41) we have two pieces which are easy to harden.

2.) Sharp corners, grooves, recesses, awkward angles, etc., are easily obtained by sectional construction (Fig. 42).

3.) Frail projecting portions of cutting contours are best made by proper inserts. (Fig. 43).

(Continued on page 10)

QUENCHING... the tail that wags the dog

Steel analysis can be perfect, temperatures "right on the nose", atmospheres ideal—but it's the *quench*—the tail end of the heat treating process that makes the rest of the operation pay off.

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Punches

Up to this point, we have considered chiefly die plates and their problems. Of course, the same principles and suggestions are valid for punches, even if generally they present fewer heat treating problems.

Here follow suggestions which refer only to punches:

1.) One of the most common errors committed in the design (or execution) of punches with a shouldered cutting point is that the change in section from the body to the cutting point is made too abruptly (Fig. 44). Correct design consists of a rounded fillet of very large radius, with a perfectly machined surface to avoid the formation of internal strains created by machining marks (Fig. 45).

2.) Punches can also have unbalanced bases. The heavy sections may be lightened by drilling holes (Fig. 46).*

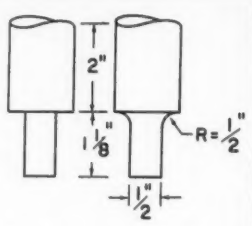

Fig. 44 Fig. 45

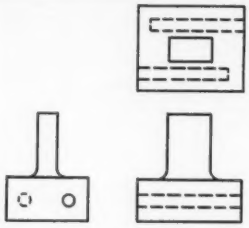
Fig. 46

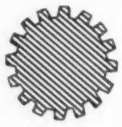
Fig. 47

Fig. 48

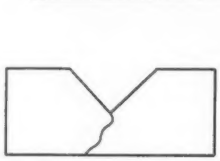
Fig. 49

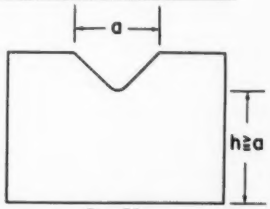

Fig. 50

3.) Large, round, concentric punches can be made easier to harden, if the central core is removed by boring (Figs. 47 and 48). In fact, in blanking punches, it is only the outer edge which does the actual cutting, so that the central part of the punch is not necessary. A well proportioned tube is more convenient for heat treating than a solid bar.*

Bending Dies

Attention should be given to the chief difficulty found in the hardening of bending dies, the simplest form of which is the so-called "V" die, which produces 90° bends.

The female die quite often develops cracks which start at the bottom of the "V" slot if the tool is not correctly designed and built (Figs. 49 and 50). There are two conditions which must be satisfied to avoid this trouble.

a.) The root of the slot must be rounded off generously, and

b.) The distance from the bottom of the slot to the bottom edge of the female die must be at least eight times the stock thickness, or equal to the die opening.

* *See addenda.*

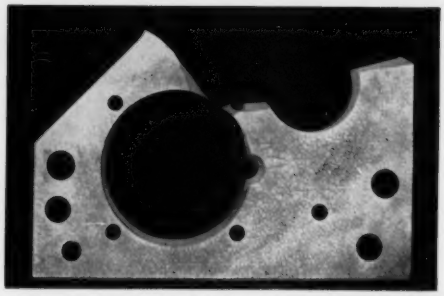
Fig. 51—Blanking die made of SAE type O1 tool steel which failed in service. The design of this die is fundamentally unsound, as it violates the principles illustrated in the Figs. 8 to 11.

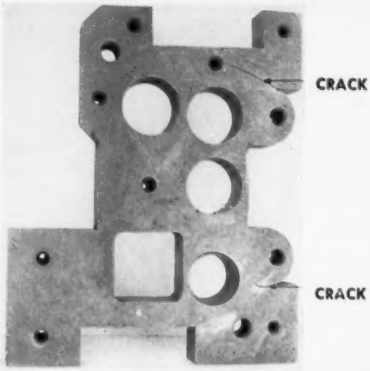

Fig. 52—Blanking die made of SAE type O1 tool steel. It is apparent that the design of this die violates a number of the design principles given by the author. Designs such as this can be expected to be a continual source of trouble in heat treatment and on the production line.

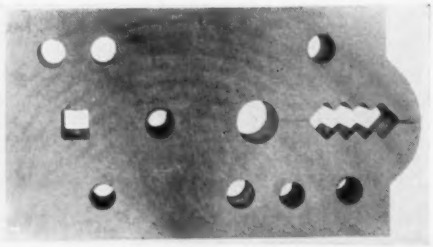
Fig. 53—Blanking die made of SAE type D2 tool steel cracked in service because of insufficient metal at both ends of the notched hole. It would be beneficial to use separate stations for punching the round hole and the notched hole.

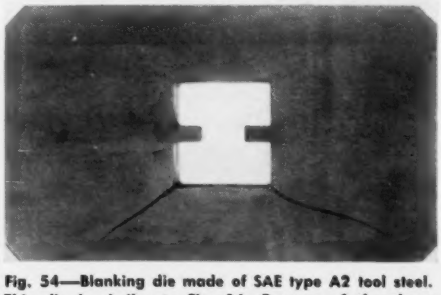
Fig. 54—Blanking die made of SAE type A2 tool steel. This die is similar to Fig. 16. Because of the sharp corners, dies of this design should preferably be made from air hardening tool steels.

Addenda

Comments by J. Y. Riedel, Tool Steel Engineer, Bethlehem Steel Company, Bethlehem, Pa.:

There is only one point in the article with which we disagree. The author discusses the balancing of sections by drilling holes in the heavy sections to lighten them. This is a very controversial subject and we do not wish to give the impression that our point of view is necessarily 100% correct either. However, in our opinion this method of balancing is likely to cause more trouble than it avoids, with the exception of when air hardening steels are being used. On air hardening steels, the use of extra holes, as the author describes, will be beneficial. On the other hand, with liquid quenching steels (either oil or water) the introduction of extra holes will definitely give a different residual stress pattern after quenching which is more likely to be unfavorable than favorable. Also, the greater the number of holes, the greater is the possibility that non-uniform hardening in the internal surface of the holes will produce high internal stress and so-called "treatment cracks." The following extract "Hardening Procedure for Tools with Holes" from some of our publications will further explain our opinion on the effect of holes in tools.

Hardening Procedure for Tools with Holes

Important in its effect upon the tendency of tools to crack in the hardening operation is the number, location and size of holes. Holes in tools ordinarily cannot be eliminated; in most tools, at least, they cannot be changed in size or location. But steps must be taken to control the ill effects of the holes. Although it is impossible to outline a definite procedure which will cover all tools, the following principles should be applied:

1.) If it is possible to do so, the tools should be quenched in such a manner that the internal surfaces of the holes harden completely. No special attention may be required where the holes are relatively large; flush-quenching may be required for small holes.

2.) If there is any possibility that effective quenching may not occur completely throughout the holes, the best procedure is to pack them, so that no hardening can occur in the holes, assuming that this condition can be allowed on the tool. Packing can be done with clay, asbestos, steel wool, or steel inserts.

3.) If only the surface of a hole is required to be hard as, for example, on a ring die, the best procedure is to flush-quench the bore while protecting the outside surface from the quench.

To summarize, the internal surface of a hole should be either uniformly hard, or uniformly soft. The worst possible condition is an irregular hardness pattern on the inside surface, because the high stress developed may produce cracks.

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THE APPRENTICE CORNER

Ed. Note: *The following is a new addition to* METAL TREATING *and is designed to aid young men who have only recently started in the heat treating industry. If you would like to see specific subjects discussed, let us know what they are.*

"Skin" That Steel!

When a woodsman in the forest cuts down a big oak tree, he sends it to a sawmill. There, what must be done before the log is transformed into clean, white boards suitable to grace the floor of your living room? That's right, they must peel off the *bark*.

Now, each bar of steel produced by a steelmill also bears a "bark" which is worse than useless. Often as deep as .030" to .125", it is a serious handicap to heat treating. What happens is this—

As the mill is hot-working the billet, rolling it into a bar, some of the carbon near the surface is lost; this is called "decarb." Consequently, when the bar cools it is found to bear a soft "skin" composed of little more than oxide of iron.

Machining off the original "decarb" is recommended by the mills, and will pay dividends in better heat treatment, lower fabrication costs, and will help to assure productive service. The job of getting rid of it generally is left up to the tool maker or machinist.

All too frequently, however, the decarb is *not* removed adequately or uniformly. The excuse is that this saves time; but actually it is a bad mistake.

There are some very good reasons why you should bear this in mind whenever you cut a piece of steel from a bar to make a tool or machine part that later will be heat treated. One of them is, any decarb you leave on will act as an *insulator*. This means for one thing that if you take a piece of steel and remove the decarb from one surface only, when that piece is quenched it will bow and bend simply because the clean side cools faster, and pulls the piece out of shape. Next, check the two sides for hardness. You will find the clean side has hardened up properly, while the opposite side has not.

Warpage, due to decarburization, and failure to achieve desired hardnesses, can be a sorry mess. Still worse, distortion can and often does reach the point of *fracture*.

When a professional heat treater receives a complaint that something is not up to specified hardness, the first thing he does is to check the spot where the customer took his readings. Often decarb is found. So he up-ends the piece—or finds some other spot where it was deeply machined—or cuts the piece in two to get at a cross-section, and takes his readings there. Higher readings tell the story; and if they are high enough there's no need to even consider re-hardening.

Then, too, a rough bar surface may contain minor imperfections, such as seams and laps, which if they are not removed will cause a tool or part to crack when heat treated.

One steel company gives the following as the most common allowances for stock removal:

Dimension	Allowance
1/4" to 1/2" incl.	1/32"
Over 1/2" to 1" incl.	1/16"
Over 1" to 2 1/2" incl.	1/8"
Over 2 1/2" to 5" incl.	1/4"
Over 5"	3/8"

Since the forging of steel is a hot-working process, the forged parts are decarburized and scaly. Now here is a hint worth storing away for future use. Long experience convinces us that no forging can be completely and properly heat treated so long as the forging scale remains on it. More and more manufacturers are finding it better to rough machine a forging, then have it normalized and annealed, before finishing it up for hardening.

Surface decarburization always has been a normal factor to the steel manufacturer, and a source of trouble to the heat treater and worry to his customers. It is a matter of concern when something fails because of the presence of a few thousandths of soft skin. It is important that you do all you can to avoid the hardening room headaches, expensive grinding operations, and early service failures from this cause. (*Material contributed by A. S. Eaves, Chief Field Engineer, Perfection Tool and Metal Heat Treating, Chicago, Illinois.*)

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bright annealing

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8—Capacities up to 2000 lbs./hour
9—Tubing from capillary size to 2½" O.D.

6

APPLICATION OF NITRIDING

TO HOT FORGING DIES

By **ALEXANDER F. SHERYS,** *Vice-President*
Porter Forge & Furnace Inc., Somerville 43, Mass.

The Drop Forging Industry has achieved astounding progress during the last two decades. It has emerged into an industry of precision and quality. Changes in equipment, methods, and processes have developed techniques of hot shaping metals to reduce overall product costs and improve the quality of forgings. Successful competition demands that production costs be cut by the purchase of new equipment, by improved efficiency and maintenance of present equipment, and by the use of latest production processes. Survival in this era of competition is not a simple problem in the forging industry because its manufacturing methods and processes probably embrace a wider and more diversified field of activity than any other producer of metal parts. This activity produces all kinds and types of forgings ranging in weight from a fraction of an ounce to several hundreds of pounds.

An important contribution to the growth of the forging industry has been the advancement in design and manufacture of forging dies and tools. The forging engineer has constantly met the demands upon his creative ability and ingenuity to design forging dies for making many new and intricate forgings. However, a major problem to the forging engineer appears to be one of increasing the life of closed-impression forging dies. Since die replacement costs are generally included in the total costs of forged parts, it is important that die impressions wear very slowly.

There are many factors directly affecting drop forging die life. Investigation and action by forging engineers, designers, and metallurgists on these factors have accomplished considerable improvement in the life of forging dies. *However, the application of surface hardening by the nitriding process to forging dies can definitely improve die life and therefore should be given more consideration by individuals in forge plants responsible for this decision. This process has been in effect for over 15 years with a high degree of success.*

These dies have been nitrided to provide longer service life through increased surface hardness, greater stability and a lubricating quality.

Factors Affecting Die Life

In order to evaluate the advantages of surface nitriding, let us first consider the destructive effects of hot-working metals to a predetermined shape by mechanical pressure in closed-impression dies.

(Continued on page 16)

The Park Neutra-gas Story:

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A patented development of Park's research laboratory, the Neutra-gas process efficiently and economically neutralizes chloride base salt baths . . . maintaining them free of de-carb in temperatures ranging from 1350°F. to 2300°F. The decarburizing oxides present are chemically converted back to chlorides by passing methyl chloride through the molten baths.

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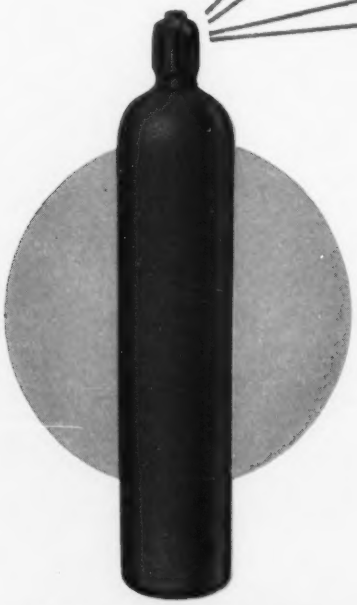
* Truly neutral chemically. Alkalinity can be maintained at zero.

At Commercial Steel Treating Corp., in Detroit, salt bath furnaces are daily cleansed of all impurities. Rectifying gas is bubbled into Park Nu-Sal Neutral Salt molten at its operating temperature of 1500°F.

Even high-speed hardening baths up to 2300°F. are easily maintained neutral. At Commercial, both pre-heat and high heat are rectified daily to zero alkalinity. Rectification is at 1850°F. in the high heat, done either on idling time or when furnaces are being used for hardening high carbon, high chrome die steels. Salt is Park Pre-heat 117, and Park High Heat 175-S.



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Patent number—2474680—Neutra-gas Process license fee, $25.00 per year.

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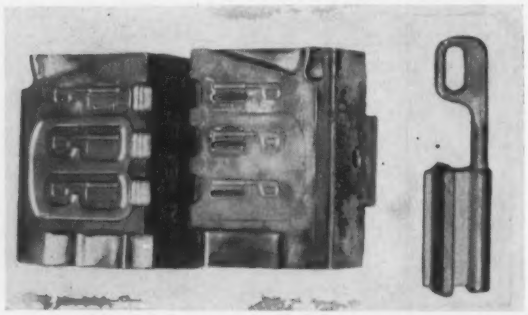
Since dies are exposed to terrific heat and pressure, they are confronted with the following destructive factors: heat, heat checks, impact, decarburization, and abrasion. The period of contact between the forging dies and the metal to be formed raises the temperature of the dies rapidly. The hot plastic metal thus causes metal sticking and prevents ease in the removal of forgings. The plastic metal exerts a stronger abrasive action on the die faces as more and more heat is absorbed during production. The heat absorbed by the die surface from the hot metal usually does not have sufficient time to diffuse into the die block. This condition causes a temporary temperature difference between the surface layers and the underlying layers. Between forgings this cycle is reversed and often results in the formation of cracks or minute cavities known as heat checks. These cracks grow progressively larger under forging impact as more and more plastic metal is forced into the minute cavities. Then, again, as the temperature of the forging die increases, the surface tends to develop a condition of decarburization. The degree of severity of these factors, at times cumulative, influences the life of forging dies. These factors cannot be accurately controlled and die life varies from one pair to another pair with the same type of forging.

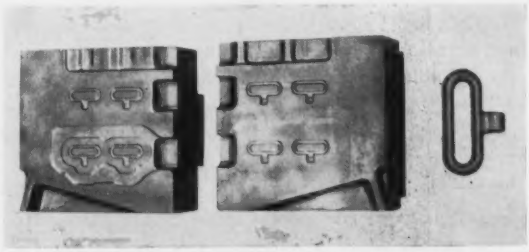


At left are the closed dies used to forge the part shown. Due to the hardness of a nitrided case trial runs are made before nitriding to assure dimensional accuracy.

Nitrided Case Characteristics

Let us now consider some of the characteristics of surface hardening forging dies by nitriding and their influence on die life increase. Until recently, the general conception was that only special steels could be nitrided successfully and alloy steels were seldom considered for nitriding. Since forging dies contain combinations of the elements chromium, molybdenum, and nickel, they can be nitrided to produce a file hard surface which is extremely wear resistant. This hard surface imparts to the die face the ability to resist abrasion, galling, scale adherence, hot erosion, metal-to-metal pickup, and metal sticking. It also improves the flow of metal in dies by reducing external friction and increasing the resistance of die impressions to distort or spread.

Since nitriding produces a hard case, one may feel that a surface so treated is also brittle. Investigations have shown, however, that nitriding increases the endurance range. Fatigue failures do not develop at the surface but are controlled to a certain extent by the core characteristics of the steel used. Since die block steels are able to withstand high impact, it is evident that surface nitriding increases this impact resistance to surface spalling or cracking. Also, fatigue resistance of a nitrided surface is increased because the case is in compression. This case diffuses uniformly into the core of forging dies to a usual recommended depth of .006″ to .010″.



The part shown is produced in the closed dies at left. If desired only portions of the dies subjected to severe wear may be nitrided.

Retention Of Hardness

Another characteristic of a nitrided surface, which is of extreme importance to forging die life, is the retention of hardness at elevated temperatures. The nitrided case can be heated up to temperatures of 1000° F. for long periods of time without softening and even up to 1200° F. for short periods of time without permanent loss of hardness. The hot hardness of a nitrided case at 750° F. is the same as when tested at room temperature. This information is based on steels containing aluminum. Alloy steels used for die blocks do not contain aluminum, and therefore are slightly less resistant to softening when nitrided and heated to the temperature ranges mentioned above.

Retention of hardness is due to the fact that a nitrided case does not soften by tempering, as is normally the case in standard carbon or alloy steels, but by complete decomposition of the nitrides. Complete decomposition of a nitrided case on an aluminum bearing steel can be accomplished by annealing at 1800° F. However, nitrided forging dies can be sufficiently softened for remachining or recutting by annealing in a temperature range of 1500° F. to 1550° F. Before renitriding it is necessary to temper finished forging dies to at least 1000° F. during heat treatment and, also, remove all traces of the original nitrided case and decarburization. A sufficiently high tempering temperature minimizes the possibility of warpage or distortion in die impressions after nitriding.

VOL 6 ISS 1 JA – FE 1955 UMI

The effects of hot metal flowing in die impressions were briefly discussed above in its relation to thermal fatigue, thermal stress, heat checking, and decarburization. These destructive factors are minimized not only by the wear-resistance and endurance qualities of a nitrided case, but also, by the red temperature hardness quality. This red temperature hardness property of a nitrided case is not similar to that possessed by martensitic steels. When forging dies during production are heated above their critical range in localized areas in die impressions, the rapid conduction of heat to the adjacent cold steel serves as a rapid cool or quench. The excessive heat transferred from the hot metal to the die surface may be so intense that hardening occurs. This condition produces a superficial unstable surface with low physical properties. The surface has an opportunity to stabilize itself by the application of additional hot metal, however, the short tempering cycle occurs during a condition of terrific impact and pressure. The result is drastic in that heat checks are formed. Since a nitrided case is not susceptible to hardening at elevated temperatures, its red hardness property is more stable than that of martensitic die steels. Also, its ability to resist heat checking or thermal cracks in die impressions is superior.

A variety of parts made in closed dies which have been nitrided.

Trial Run Before Nitriding

In the application of nitriding to forging dies, it is essential to understand some of the factors involved. Since a nitrided case is file hard, it is practically impossible to incorporate changes in forging impressions after a nitriding treatment. Therefore, if any changes are required, they should be made before nitriding. If there is any doubt concerning the accuracy of forgings produced from a pair of dies, then the procedure to follow is to first use the dies in production for a single run. On new forging jobs it is possible to correct or change forging impressions after a trial run of dies for stock try-out size before nitriding. Generally, only the impression die faces are surface hardened with a nitride case. The remainder of the die surfaces can be treated with stop-off materials which prevent any diffusion. Since bottom die faces usually wear more than top die faces, it may be necessary only to nitride bottom dies. Also, where inserts are used to resist wear in localized die impression areas, it may be decided to limit the nitriding to the insert. These and other variations are possible in the application of nitriding to forging dies and tools.

In conclusion, the purpose of the discussion presented above is to create more interest, investigation, and application of the nitriding process to forging dies. Nitriding does possess advantages as a surface hardening procedure for increasing forging die life as high as 400%. Nitriding has proved itself in actual production for over 15 years. It is not the answer to all die failures but appears to be the best method of surface treatment to impart added resistance to the wear, wash, and checking of die impressions. Nitriding is capable of playing an important role in the drop forging industry to improve on current practices of metal processing. Commercial and industrial heat treaters can play a definite part in the application of this practice by close co-operation with drop forging concerns because of their know-how in the techniques and methods of the nitriding process. ■ ■ ■

For further information circle No. 5

VOL 6 ISS 1 JA – FE 1955 UMI

A Year of Progress

TITANIUM IN 1954

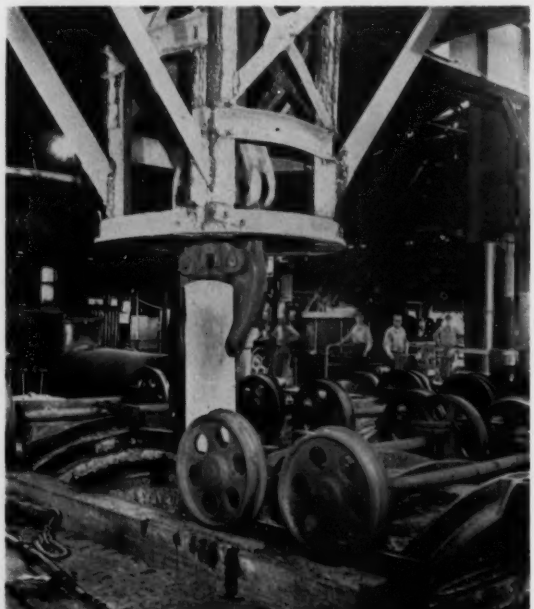
By **T. W. LIPPERT**
Manager of Sales and Technical Service
Titanium Metals Corp. of America
New York, N. Y.

After four years of struggling with metallurgical unknowns and obstinate production techniques, the producers and processors of metallic titanium in 1954 scored such encouraging gains as to assure a confident future. The 1954 production of basic metal more than doubled the 1953 figure. More important were the impressive improvements in quality, the significant reductions in metal processing losses, and the evolution of a firm and documented physical-metallurgy pattern which assures in 1955 and 1956 many new and very advanced alloys of exceedingly high strength and for high-temperature service.

Each of the two commercial producers of raw titanium sponge, Titanium Metals Corp. of America and E. I. du Pont de Nemours, achieved 10 tons-per-day capacity production by late summer. Compared with a 1953 output of 2250 net tons, total 1954 sponge production is estimated by Government agencies at 5250 tons, of which TMCA and du Pont contributed about 2500 tons each, the Bureau of Mines added 150 tons and other pilot units made up the remainder. Imports from Japan followed a rapidly rising curve by mid-summer, the year's total being 250 tons, the major portion of quality metal originating in the Toho Titanium Co. plant at Chiagasaki City, Japan, a Mitsui enterprise.

The very sharp increase in sponge production late in the year brought about a seeming paradox of an over-supply of the material in face of repeated Government announcements that present and planned capacities are insufficient to meet requirements of the Air Forces alone. Actually, aircraft manufacturers cannot use titanium metal for any given application until assured of a sufficient supply to fill that application completely. Therefore, a sharp increase in production necessitates a temporary stock-piling of sponge by the Government such as that which occurred late in 1954. It is anticipated that all or part of the stock-piled sponge will be melted and converted during the coming year as additional applications are made in jet engines and airframe programs.

Drastic tightening of customer specifications throughout 1954 was reflected in a succession of production upheavals. However, industry sources do not anticipate much further burdensome and costly narrowing of specifications in 1955, for titanium mill products are today moving under customer limitations of a rigidity not to be duplicated in other structural metals having decades of production history.



Four-thousand pound titanium slab being removed from soaking pit for continuous rolling into 48" sheet.

On the technological front, no new or particularly significant technique for producing the basic sponge metal has made its appearance. However, both the Electro Metallurgical Co. and Imperial Chemical Industries have attracted considerable attention by reverting to a modification of the

(Continued on page 29)

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Storage cost (4¢/cyl.)	.92	.04	
Handling labor/100 cu. ft.	.025	.001	
Storage cost/100 cu. ft.	.020	.001	
Cost of product/100 cu. ft.	1.00	.410	
Cost of equipment/100 cu. ft.	—	.125*	Amortized in 3 years
Cost of electric power/100 cu. ft.	—	.060	
Total cost/100 cu. ft.	$1.045	$.597	
Savings in operation/100 cu. ft.		.448	
Percentage savings in operation cost		44%	
and after equipment is amortized, savings are		55%†	

*This figure arrived at by the following assumption: 500 cu. ft.- per hour dissociator costs approximately $4500 installed. Assume equipment to be completely amortized in 3 years, then amortized cost of equipment equals $.125 per 100 cu. ft.

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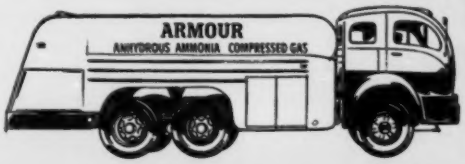

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HEAT TREATING TITANIUM

By **LEO SCHAPIRO, Ph.D.,** *Chief Metallurgist, Douglas Aircraft Co., Santa Monica, Calif.*

Although it can be annealed, commercially pure titanium is classed as a non-heat treatable metal because it has a close-packed hexagonal structure which becomes cubic at elevated temperatures and then too suddenly reverts to its original condition when it is cooled. However, a number of titanium alloys are sensitive to thermal treatment.

Fig. 1—Grain structure of heat treated alpha-beta titanium alloy. Magnification 75 times.

Contemporary alloys of titanium can be briefly classed as alpha, beta, and alpha-beta materials. Alpha alloys usually contain aluminum and, having the hexagonal structure of pure titanium, are generally non-heat treatable. Beta alloys are at this writing strictly experimental metals containing various percentages of chromium, manganese, iron, or molybdenum; they have a cubic structure and are also non-heat treatable. Alpha-beta alloys contain both alpha and beta stabilizing elements, have a body-centered cubic and hexagonal close-packed structure at room temperature, and are generally quite heat treatable.

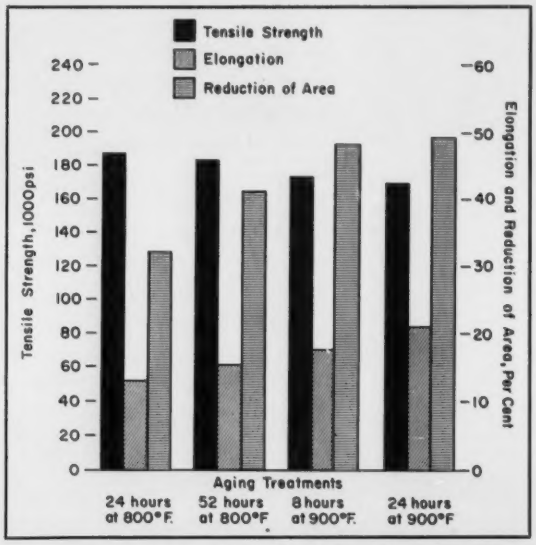

Fig. 2—Properties of 1-Cr, 1-Fe, 3-Mn, 1-Mo titanium alloy, solution treated for one hour at 1300°F. and aged as indicated.

Specific alpha-beta alloys that are now available and most likely to be processed by the heat treater in the near future are: 3Mn-complex; 7% Mn; 3AL-5CR; 4AL-4Mn metals—most of which are made by more than one of the basic titanium producers. Because there is a change in their atomic arrangement at elevated temperatures, all of these materials are heat treated in the same general manner as steels—not like aluminum and magnesium alloys, whose heat treatment involves a change in solid solubility. A typical heat treated microstructure is shown in Fig. 1.

In the solution phase of the treatment, the titanium alloys are heated to temperatures of 1250° to 1450° F. for a period of not more than one hour

PHYSICAL PROPERTIES OF TITANIUM ALLOYS

Alloy	Yield Strength		Ult. Tensile Strength		Elongation, %	
	Before HT	After HT	Before HT	After HT	Before HT	After HT
4% Mn	75,000	110,000	100,000	125,000	20	15
6% FeCr	110,000	125,000	120,000	155,000	18	10
7% Mn	120,000	160,000	130,000	170,000	18	7

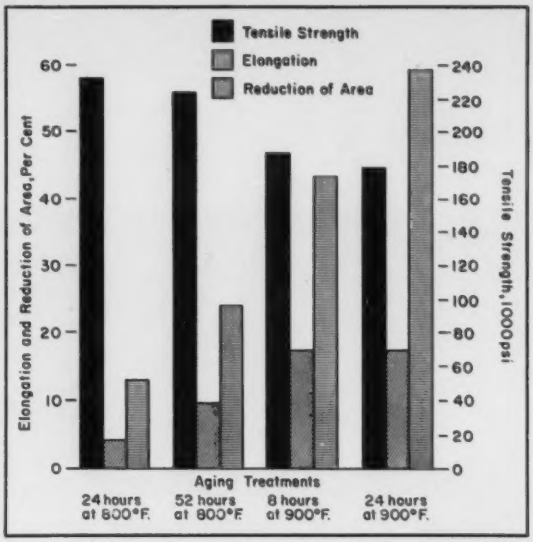

Fig. 3—Solution treatment of same alloy in Fig. 2 at 1400°F. results in higher strength and greater variation in properties after annealing.

and then water quenched. The specific temperature employed in any given instance depends, of course, on the thickness of the materials being treated. Heating for more than an hour must be scrupulously avoided in order to prevent excessive oxidization. The effects of solution treatment temperature and various aging treatments, on 3% Mn-complex alloy are shown in Figs. 2 and 3.

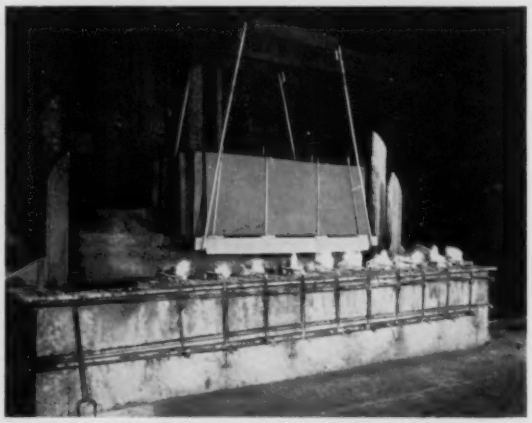

Fig. 4—Descaling titanium sheets in a sodium hydride bath at Rem-Cru Titanium, Inc., Midland, Pennsylvania.

In the aging phase of the treatment, the materials are heated to temperatures of 800° to 1100° F. for periods of 2 to 48 hours and then either air cooled or water quenched. The lowest temperature is preferable where it is necessary to minimize oxidation, but its use involves a maximum heating interval.

An inert atmosphere is usually desirable in heating titanium, because it will prevent oxidization. However, its use is rarely practical because excessive oxidization can be avoided for most purposes simply by limiting the treatment interval. When necessary a descaling method such as that shown in Fig. 4 can be used.

Physical properties of titanium alloys, before and after heat treatment, are indicated by accompanying graphs and a table.

Both commercially pure titanium and titanium alloys are annealed by heating them at 1000° to 1200° F. for periods of 30 minutes to an hour. But, where the commercially pure materials are either water quenched or air cooled, the alloys are cooled by slowly reducing furnace temperatures to about 800° or 900° F. and then exposing them to air at room temperature.

Slow cooling is specified for alloys, because rapid cooling can cause some drastic hardening effects, including extreme embrittlement. A good slow-cooling rate for titanium alloys is about 300° F. per hour.

Some typical, current applications of titanium are shown in Figs. 5 and 6. The expanding use of this metal and continued research to develop newer, more heat treatable materials will serve to make it a more familiar sight in heat treating plants and departments in the future. ■ ■ ■

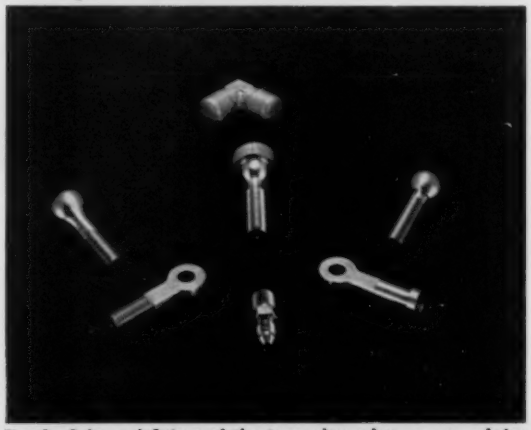

Fig. 5—Bolts and fittings of the types shown here are now being made from heat treatable titanium alloys, instead of steels, in order to reduce weight without sacrificing strength.

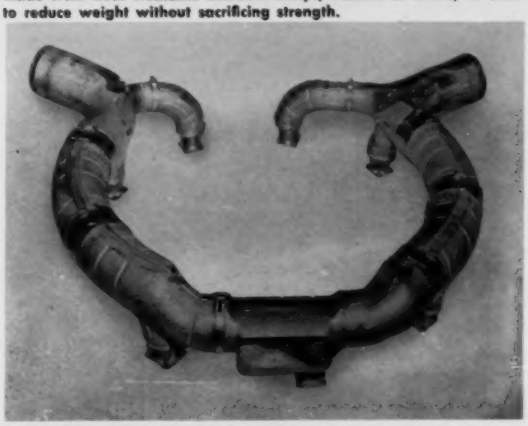

Fig. 6—This helicopter exhaust collector and shroud is one of the largest components fabricated from titanium thus far.

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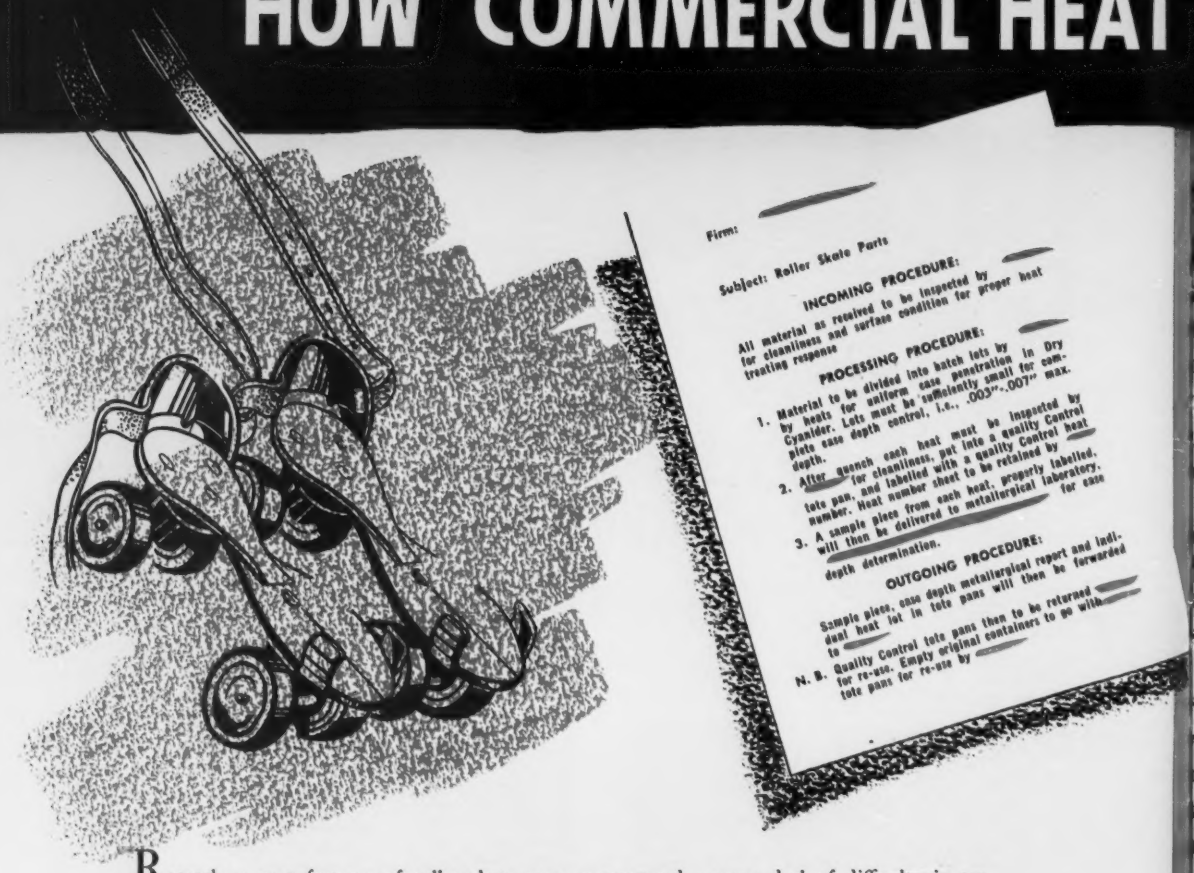
Firm:
Subject: Roller Skate Parts
INCOMING PROCEDURE:
All material as received to be inspected by for cleanliness and surface condition for proper heat treating response
PROCESSING PROCEDURE:
1. Material to be divided into batch lots by heats for uniform case penetration in Dry Cyanider. Lots must be sufficiently small for complete case depth control, i.e., .003"-.007" max. depth.
2. After quench each heat must be inspected by for cleanliness, put into a quality Control heat tote pan, and labelled with a quality Control heat number. Heat number sheet to be retained by
3. A sample piece from each heat, properly labelled, will then be delivered to metallurgical laboratory, for case depth determination.
OUTGOING PROCEDURE:
Sample piece, case depth metallurgical report and individual heat lot in tote pans will then be forwarded to
N. B. Quality Control tote pans then to be returned for re-use. Empty original containers to go with tote pans for re-use by

Recently a manufacturer of roller skate parts encountered a great deal of difficulty in trying to find a source of heat treating for a particularly hard job. So serious was the problem that at one time consideration was given to installation of the necessary equipment at the manufacturer's plant. However, equipment would have cost over $20,000 plus the additional expense of labor, plant space, insurance, supplies, and above all, the metallurgical supervision required to control this intricate work properly.

The manufacturer turned to a local commercial heat treater to handle the work and even offered to install the required equipment. However, they were able to handle the job to the utmost satisfaction of the customer, using existing facilities.

The cyaniding operation involved required a case dept of 0.003" to 0.007." Samples of each batch processed are sent outside to a commercial metallurgical laboratory for inspection and testing. After OK, the parts and metallurgical report for each batch are shipped to the customer. The control sheet shown here is actually in use at **the plant now doing the work and conveys** some idea of the thoroughness to be expected from those commercial heat treating plants which are members of the Metal Treating Institute.

A reprint of the article, "Heat Treaters Cite Short Cuts to More Effective Purchasing" is available from each of the companies listed. This handy reference will prove of value when ordering heat treating.

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Cooperation Between the

HEAT TREATER

and the

STEEL MANUFACTURER

By **C. B. POST,**
Chief Metallurgist,
The Carpenter Steel Co., Reading, Pa.

The problem of making tools and dies that will give long and trouble free service is not a new idea by any stretch of the imagination. Actually, it is a goal to which we all, who are engaged in the fabrication of materials and their proper heat treatment, have long hoped to attain. In the past ten to fifteen years, we were faced with a number of accelerated tooling programs as required by the military services—we were faced with shortages of skilled tool makers and operators as well as many of the strategic alloys. Yet, with the combined efforts of industry we did a pretty good job.

As of today, we are in a different situation. Military programs are at a much lower level. Most metals and heavy goods are reasonably plentiful, the labor market is more abundant in most localities and in general, we have reverted to what is generally agreed to be a freer economy. But along with these factors we are again finding it necessary to recognize the laws of supply and demand, and more important, the workings of a competitive market. The price for existing and prospering in a market such as this covers a multitude of factors much too numerous to mention here. But basically, we are all still concerned in making that tool, die or mechanical part that will give long and trouble free service.

After all, a steel manufacturer cannot exist if it has no customers to buy its product. A heat treating plant cannot exist if its reputation is such that it has no requests for heat treating services. In other words the steel producer, the tool maker, and the heat treating sources are so closely allied that it would be rather difficult for any one to exist without the help of the other. If this be a true statement. it would then follow that the so-called family could operate most effectively when there is a free exchange of information, ideas, recommendations, etc.—and, of course, this is necessary because of the large number of grades and types of steels that are available today. This number will not get any less but will undoubtedly increase. So that we can better understand each other, we at Carpenter Steel, over a period of years, have followed the general philosophy that to successfully produce the kind of tools and equipment that industry needs, four fundamental conditions must be satisfied; these are as follows:

1. The tool must be correctly designed.
2. It must be made accurately to blueprint plus proper machining allowances from the original bar stock.
3. The proper kind of steel must be selected (this not only involves proper type but also the quality).
4. The correct heat treatment must be followed.

In discussing our philosophy on this problem, we assess equal value to each of the four major points. *If a tool is incorrectly designed there is very little that can save it.* If it is machined off-size or with bark remaining on the tool, it is usually

headed for the scrap box. On the other hand, proper design and accurate machining are of very little use if the wrong steel has been selected. Last, but not least, I believe we all recognize that a perfect tool can be ruined in heat treatment—and so all four requirements must be satisfied in order to avoid trouble. Frankly, if they were all followed as a daily thing, we could reduce our service staff tremendously, and still put more time and effort on the perfecting of our present steels plus the developing of new ones.

But, getting back to our four fundamentals for the moment, I realize that it may be somewhat difficult for a group of experienced heat treaters to recognize that our daily problem can often be rationalized so easily and into such a simplified program. However, as simple as it seems, the actual ability to reason out some of the basic mistakes depends entirely upon getting the facts—and many times that is rather difficult.

Typical Tool Failures

For example, we will illustrate a number of case studies of tool failures. These failed for a variety of reasons—however, once the facts were known it was possible to diagnose the reasons for failure and to offer a program for preventing similar occurrences in the future.

For example, Fig. 1 shows a clear instance of tools in which the design versus selection of steel has been given very little consideration. This is a

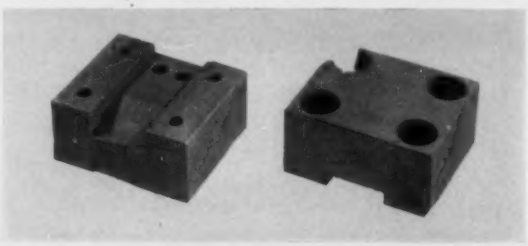

Fig. 1—Combination bending and notching die designed with holes in critical areas. Insufficient stock was allowed between large diameter holes and edges of die.

combination bending and notching die which was constructed from a 1% carbon water hardening steel. You will note that this section has holes placed at very critical places and on the one side of the die the remaining wall is only $\frac{1}{16}$" thick. That is the wall between the O.D. of the hole and the outside of the die. This naturally presents a very severe quenching hazard during heat treatment and the evidence simply confirms what really should be anticipated. The best heat treater in the world is bound to have some trouble on quenching delicate sections such as this.

In Fig. 2, we have a blanking die made from a straight manganese oil hardening steel in which the surfaces are loaded with minute cracks. This type of crack is normally associated with the grinding operation and we see examples every day in which a tool has been abused in grinding and has a similar appearance.

However, there are other aspects which can have a definite bearing on a situation such as this. We know from experience that if the surfaces are heavily carburized or decarburized, then grinding cracks will have a high frequency of occurrence.

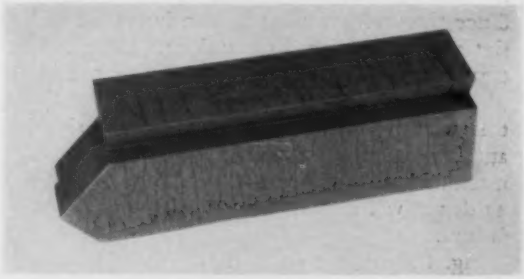

Fig. 2—A blanking die exhibiting severe surface cracking ("grinding cracks") which can be attributed to one or a combination of factors such as improper grinding, carburizing or decarburizing, overheating, improper tempering.

Secondly, if the tool is not tempered properly or if the tool has been overheated it presents a tender surface and which is very apt to crack in grinding even with the best grinding practice. These various possibilities are mentioned because even though a die may show characteristic grinding cracks there are other factors which can and may have an indirect bearing on the job. Therefore, while the average job in this category is a result of poor grinding practice, improper furnace technique in hardening may be indirectly responsible for the failure.

In Fig. 3, we have a somewhat unusual situation. This is a portion of a plastic mold die made from a manganese oil hardening type of tool steel which cracked during hardening and of course the hardener was blamed for the end results. However, the

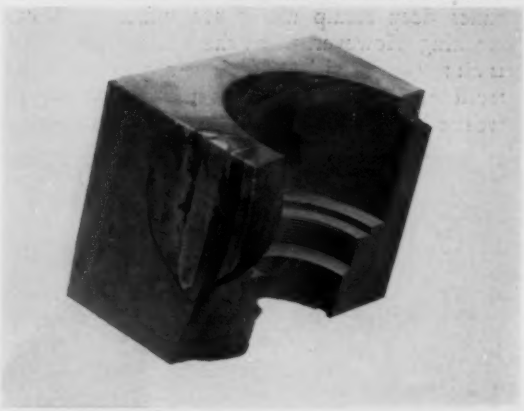

Fig. 3—Portion of a plastic mold die. Note welded area which led to failure during hardening.

hardener had enough foresight to ask for a complete examination of this tool because he was rather concerned about this occurrence in a steel which normally does not crack readily during heat treatment.

Further investigation of this problem indicated the following: This tool was machined on the night shift, and at times, unusual things happen on the night shift. In this instance, the machinist allowed his end mill to cut down the side wall. Since the tool was needed in a hurry he had the slot welded up, faced off and sent along for heat treatment the following day. It is of course possible that with more time and careful technique this would not have happened but it simply is another example of a mistake that occurred in machining and yet for all intent and purposes the hardener would have gotten the blame for the failure.

Fig. 4 shows a cracked punch made from a 1% carbon, water hardening steel and which illustrates one of the most common types of failure that we see in heat treatment. There are two interesting facts about the history of this particular tool.

Fig. 4—This cracked punch illustrates the most common cause of difficulty during heat treatment—failure to remove mill bark, the decarburized layer existing in most tool stock.

The major diameter of this tool is the same diameter of the original bar stock and none of the bark has been removed. Failure of the machinist to remove bar bark prior to hardening is one of the most common causes of tool failure that are called to our attention. Of course, the matter of deep stamp marks is not helping the matter any and at times deep stamp marks are sufficient to cause cracking. However, when the two are combined it is almost a closed issue and we are bound to have trouble. Again, this is no reflection on the heat treater but on the other hand is a reflection on the man who made the tool. So many times people feel that they can economize in the manufacture of tools by not machining off the bar bark. This is false economy and usually results in added expenses over and above the original cost of properly constructing the tool.

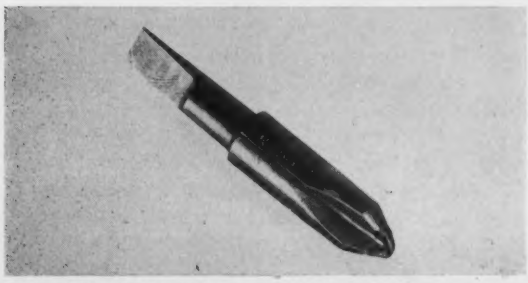

Fig. 5—Slight decarburization on tools similar to this power-driven bit can cause excessive wear.

Fig. 5 shows a simple power screwdriver bit and here is an example where good heat treating practice is of utmost importance. These bits are machined from bar stock, heat treated and put into service without any grinding or finishing operations. We have had considerable experience with production records on these small tools and know that trouble can be expected when we find as little as .003" of decarburization on the tapered end. For example, a bit that is entirely free of decarburization will run continuously on an accelerated test for 10 to 15 hours before some wear starts to take place on the nose. On the other hand with as little as .003" decarburization on the nose of the tool it will start to show noticeable wear in about one-half hour.

Fig. 6 shows the etched cross section of four different piston pins made from SAE 3312 steel. The contrast in etching is a result of the carburized case which is present on these pins to about .050". There is a very interesting history in back of this particular application involving these piston pins that are used in reciprocating aircraft engines. Carpenter Steel company was originally involved in a discussion on these parts because of the results which were being obtained in "Magnaflux" testing, the amount of non-metallic inclusions, and the amount of indications that were seen after testing. The discussions involved all levels of personnel even up to top management and there was as much as $50,000 in parts involved.

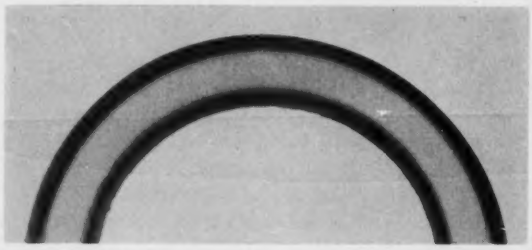

Fig. 6—Typical etched cross-section of piston pins which became the subject of much discussion. See Fig. 7 for microstructure.

However, during the course of our part in this investigation we had an occasion to examine the heat treating characteristics of pins that were produced by various suppliers and ran into an amazing situation. Pins from one of these suppliers showed a very coarse acicular martensite in the case, with fairly large percentages of retained austenite and heavy blocky carbides. The characteristics of the carburized case from the other three suppliers were entirely satisfactory for this grade

of steel.

Fig. 7 shows a typical carburized structure just mentioned. I believe we all recognize that a case of this nature is not at all desirable from many standpoints and in an attempt to define some of these bad features comparative impacts were made on pins from all four sources. Impact tests made on three sources with the desirable microstructure showed a range of 35 to 40 ft-lbs. In the case of the pins which showed the undesirable microstructure the impact values were of the order of 10 to 11 ft-lbs. Here again is a clear example of the importance of good heat treating practice. It is interesting that this investigation started over what was thought insufficient evidence for "Magnaflux" rejection, and in the course of examining these piston pins we uncovered a serious defect in heat treating.

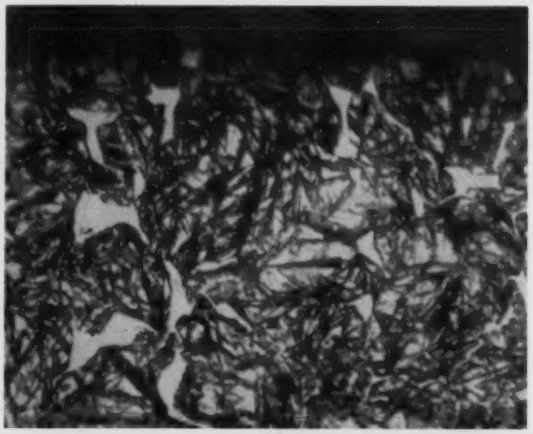

Fig. 7—Etched microstructure of the carburized case seen in Fig. 6. Note the presence of embrittling, massive carbide.

And so, it can be seen from these few examples, that in many cases our most common answer for failed tools can be found in four major categories. As a result you may ask what can be done to remedy some of these mistakes. In our own case, we have had a company policy for many years of providing steel users with any information that is pertinent to the use, selection and handling of various grades of steels that we manufacture. Carpenter is possibly the first company to show in print the full chemical analysis range of the various tool steels that they manufacture. This has been supplemented by the Matched Set Method of Selection—the issuing of quarterly Service Bulletins and the every day availability of technical men from our Metallurgical Department. We have long recognized the importance of close contact between the producer, the user and any allied group involved in the processing of tools, dies and machining parts. However, all of this is quite obviously not enough and never will be enough as long as we are dealing with a human being. The old saying of "haste makes waste" is still basically true in an economic sense and the first word of this phrase is sometimes the principal reason for many of our mutual problems. We are all familiar with cases where a company could not wait long enough to get delivery of the proper size bar stock—made a tool from a size that did not allow proper clean up in machining and ultimately cracked in hardening—the case of the press operator who had to have his tools before they were properly drawn—these and many others.

The steel producer and the heat treater should be especially vigilant in following up tool breakage. Too often, trouble is passed over by a quick answer, such as "the steel is no good" or "the heat treater is terrible." This type of hasty decision solves nothing and usually makes all persons concerned pretty irritated. As individuals, it is quite likely that most of us at one time or other has made at least one wrong hasty decision—that is only natural—yet the point that I would like to make is that our present day scope of technical knowledge and ability is such that with any reasonable approach to a problem we should find the answer. We all must find the answers, so that heat treatment will evolve and find new techniques, the steel producer can develop better steels, and the designer, will recognize clearly what can, or cannot, be done with any steel and a heat treatment.

■ ■ ■

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Right or Wrong In

LABOR RELATIONS

By **LAWRENCE STESSIN**

This new department will present, in each issue, a round-up of day to day in-plant problems and how they were handled by management men. Each incident is taken from a true-life grievance which went to arbitration. Sources of these cases will be given upon request.

Does "Equal Pay for Equal Work" mean that all employees doing the same jobs have to receive similar rates of pay?

What Happened:

The Company had a policy which read as follows: "The principle of equal pay for equal work shall be applied without discrimination." Four employees were in the same department, doing the same work. The workload was about equally divided. But one of the employees (Pete Dalber) was getting about $5.00 a week more than the others. This was the result of a merit-rating increase. The workers contended that because they did the same work as Dalber, they too should get the same merit raise, in line with the principle of "equal pay for equal work." Everyone agreed that all four employees turned out about the same amount of work.

What do you think—were the workers: Right ☐ Wrong ☐

What Arbitrator Ralph Seward Ruled: "Merit rating is concerned not with what the employee does but how he does it. To contend that merely because employees are performing the same kind of work they should receive the same merit rating indicates the same confusion between the functions of job classification and merit rating. Such a contention would destroy merit rating entirely. Though the three employees are competent workers, none of them has shown the same level of initiative, none has demonstrated as thorough an understanding of his work or a comparable ability to meet unusual scheduling problems effectively and without advice and direction of supervision. The grievance is denied."

If management recalls the "wrong" man after a layoff, must it pay for its mistake?

What Happened:

Crandell and Krupa were close friends and worked side by side in the plant. Crandell had greater seniority than Krupa but when business sloughed off, both men were laid off. When things picked up again, the Company recalled Krupa, even though he had been with the company two months less than Crandell. Company policy provided for recall on the basis of length of service. Six weeks later, Crandell was told to come to work. A short time after that he filed a grievance and claimed that he should have been recalled before his friend Krupa. In checking the charge the company found that it had made a mistake in its seniority roster. However, it maintained that:

1. Crandell should have protested Krupa's recall as soon as he heard about it.
2. Crandell knew that an error had been made and should have reminded the company instead of waiting so long.
3. Crandell should have asked the company to check his seniority status.
4. The company should not be penalized for an "honest mistake," particularly where the employee involved knew that an error was being made, and could have cut down the company's potential liability by speaking up sooner.

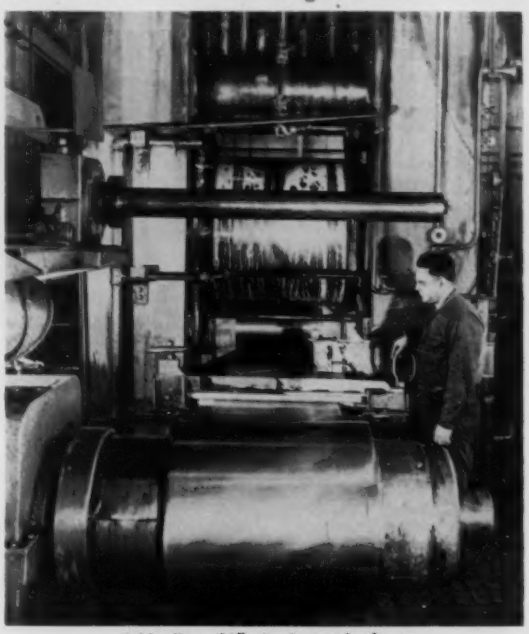
Was the Company: Right ☐ Wrong ☐

What The Arbitrator Ruled: "This arbitrator believes that the company made an honest error. It is beyond my power, however, to correct that error. The fact that Crandell did not ask the union to intervene in his behalf until a later date cannot be construed as a forfeiture of his seniority rights. Seniority records, therefore, must be adequately maintained." In addition, the arbitrator offered some wholesome advice to management. He pointed out that many contracts put a time limit in which a grievance may be filed and if this company had been astute enough to negotiate such a protection, it would not have been liable for the six weeks' pay it had to shell out to Crandell. ■ ■ ■

Titanium in 1954 (Cont.)

original method of producing metallic titanium, using sodium to reduce the tetrachloride, as against the magnesium (Kroll) reduction of the tetrachloride. The only fully-integrated facility operating or in the planning stage is Titanium Metals Corp. of America, which carries ore through the entire productive sequence to finished mill products, and is unique in that it recycles the by-products of reduction, i.e. chlorine and magnesium. In the melting of titanium sponge, the double-melting and vacuum-melting techniques, announced early in the year by TMCA, are apparently becoming standard practice throughout the industry.

That this new structural metal has so quickly attracted so many blue-ribbon American industrial firms into heavy technical and financial commitments is in itself a massive vote of confidence in titanium's unique high strength with light weight and superior corrosion resistance. These are properties much in demand by the civilian economy, and in particularly immediate demand by military contractors. For, as announced late in the year by the office of the Assistant Secretary of Defense: "We believe that the successful development and engineering application of titanium in this country will represent a major technological breakthrough. It opens up the possibility of military designs, with performance characteristics that would be impossible of attainment with other known materials and could have an important bearing on the outcome of our technological race." ■ ■ ■



Cold-rolling 36" titanium strip-sheet.

New **RECIPROCATING HEARTH FURNACE**

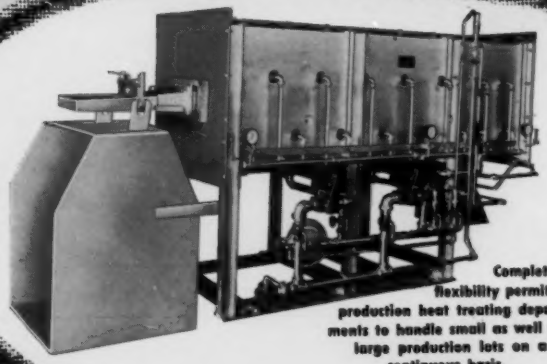
Patent 2,671,654

By AGF Pioneers, the originators and builders of Reciprocating Furnaces since 1921. Features include stationary muffle and complete atmosphere control.

Carburizing, case hardening, "Ni-Carb" ammonia-gas carburizing, clean hardening, etc. of parts ranging from balls for ball point pens to heavy forgings can be accomplished in the same model without any modification.

Newly engineered fully automatic feeding device eliminates costly work handling.

Individualized treatment assures uniformity of product. Each piece is individually heated, subjected to the atmosphere and quenched. Disadvantages of batch heating and quenching are eliminated. Work can be observed throughout the processing cycle. Only the work enters and leaves the furnace. Baskets, trays, chains and other troublesome mechanisms are eliminated.



Complete flexibility permits production heat treating departments to handle small as well as large production lots on a continuous basis.

Sizes in production capacities up to 600 pounds per hour.
Representatives in principal cities.

Send your Bulletin 850 which will help us produce a quality product at lowest cost.

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For further information circle No. 9

INSTITUTE NEWS

1955 Spring Meeting

The Ambassador, Los Angeles, California, will be the site of this year's Metal Treating Institute Spring Meeting on May 9th, 10th and 11th.

A complete, packed-full program is being planned to provide not only technical interest but to allow some enjoyment of California's famous climate, scenery and other well-known attractions. West coast members are working on a schedule which will try to please everyone by offering considerable variety.

Those members present at the last Spring Meeting, (The Homestead), will recall that the City of Los Angeles presented a formal invitation to the Institute through A. E. Leidig, Hollywood Heat Treating Co., of the same city.

Official reservation blanks for The Ambassador will be sent to all members within the next month.

The Ambassador, Los Angeles, Calif.

Scholarship Winner Selected

Mr. Robert G. Howell, an employee of Anderson Steel Treating Company, Detroit, Mich., has been selected as the winner of the scholarship awarded by the M T I through the cooperation of International Correspondence Schools. Mr. Howell has been engaged in heat treating for the past four years.

ICS has been assisting a number of member companies in the establishment of home study courses in heat treating. Recently, a course of study was outlined which is designed to tie in closely with the M T I apprenticeship standards. Complete information on this new course will be made available in the near future.

Ace Heat Treating to Offer Local Industry New Name, New All-Inclusive Metal-Treating Facilities

Ace Heat Treating Company of 611 Grove Street, Elizabeth, New Jersey, has announced a change of name to Ace Metal Treating Corp. in line with expansion of its facilities to include a unique, all-embracing metal treating service. Still tank and barrel plating operations, as well as welding, thread-rolling, silver brazing and black oxiding, have been added to the already existing Ace facilities for all types of heat treating, barrel finishing and blast cleaning.

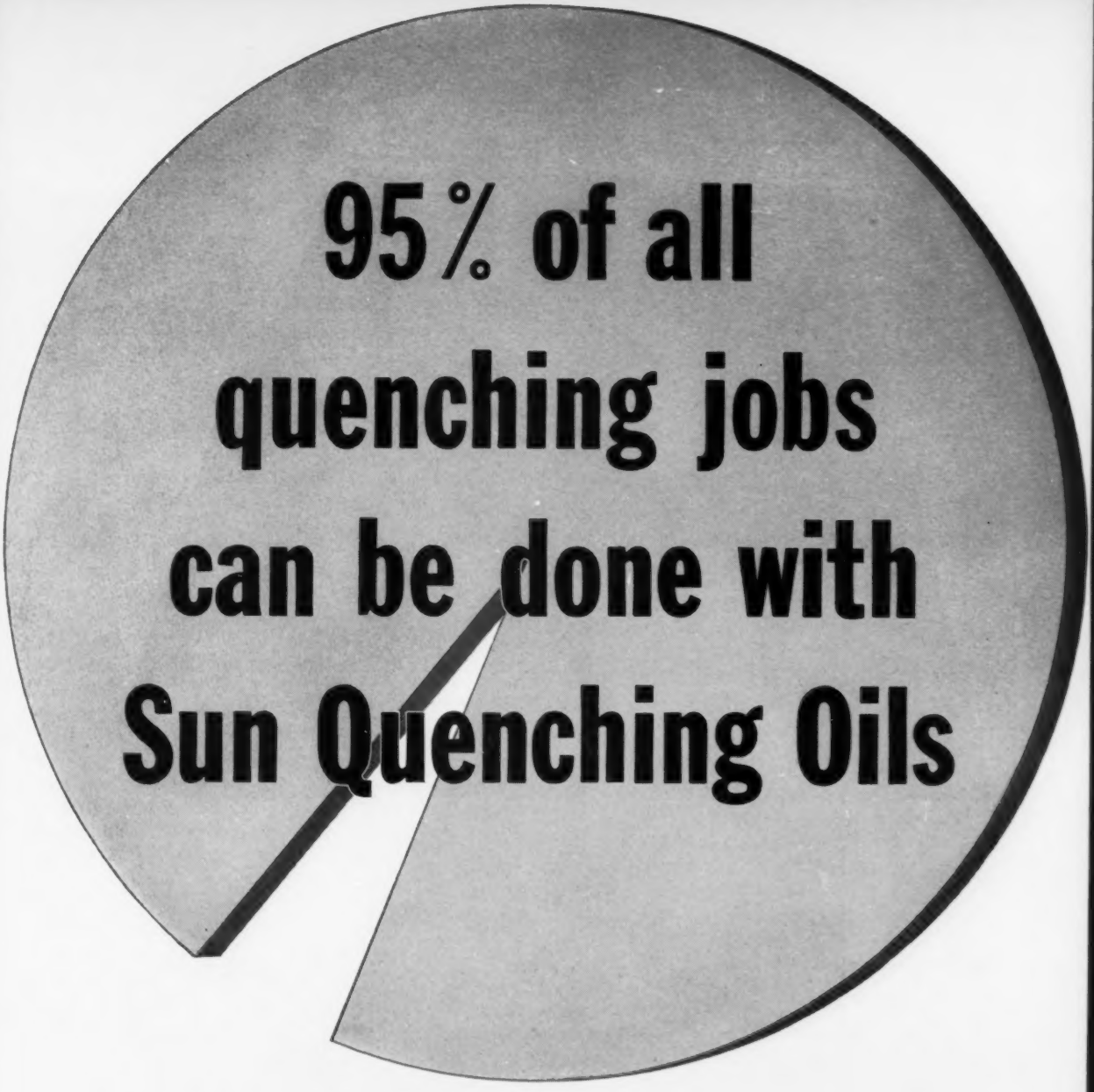
Herbert Dobkin, Vice President, was honored by the A.S.M.E. recently with a Certificate for his years of service to the Society.

Mr. Dobkin, who holds the degrees of Mechanical Engineer and Master of Science in Metallurgy from Stevens Institute of Technology, was presented the Certificate at a dinner meeting held at the Elizabeth Elks Club.

V. H. Erickson at Allied Metal Treating

Mr. Charles I. Wesley, president, Allied Metal Treating Corp., Kenosha, Wis., recently announced the appointment of Mr. Verle H. Erickson as Metallurgist and General Manager.

Mr. Erickson was formerly associated with American Steel Treating Company, Snap-On Tools Corp., A. O. Smith Corp., and Allis-Chalmers Mfg. Corp. He holds a degree in metallurgical engineering from Purdue University and has written several papers on machinability and isothermal heat treatment.



. . . AT MUCH LOWER COST

For 95% of your quenching jobs, you don't have to use expensive compounded oils. Sun's low-cost quenching oils will give the same uniform results, assure fast and thorough quenching, help increase production and lower maintenance. The booklet "Sun Quenching Oils" tells the complete story. For your copy, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MR-1.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

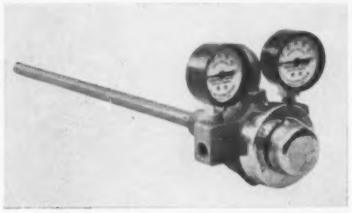
SUNOCO

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL

Thermostatic Pilot Controller

A new thermostatic pilot controller, unusually small in size and rugged in construction, has been developed by Fulton Sylphon Division, Robertshaw-Fulton Controls Company.

The new pilot controller, measuring only $3\frac{13}{16}$" in width,



provides accurate temperature control of liquids or air when used in conjunction with valves, dampers, and other controls. It is readily employed in control systems of electro-plating tanks, chemical vats and processes, instantaneous water heaters, and other applications in which rapid response and adjustable control characteristics are required, the Company announcement said.

For further information circle No. 11

Controlling Smoke By Sludge Removal

Among the causes of smoking power plant and furnace installations, the factor of sludge deposits in fuel oil seems most frequently neglected according to Magnus Chemical Co. Inc., South Ave., Garwood, N. J. Yet with today's heavy oils and the ability of modern burners to handle oils which would not function in the burners of yesterday, this factor of sludge is of prime importance. Storage tanks tend to accumulate sludge contents which seriously interfere with efficient functioning of the burners, with the result that smoking, often blamed on other causes, is the rule rather than the exception.

Reports from many industries now indicate that the use of Magnus Clerex Concentrate in fuel oil storage tanks will solve the smoke problem. Magnus Clerex is a simple, safe combination of dispersants which break down the sludge as well as the water of condensation which is the basic cause of sludge. The compound is simply added in the proper proportion to the sludged oil in the storage tank. Heating speeds up the dispersion, but is not essential. In a short time after adding the material, the sludge will be found to have been dispersed throughout the body of the oil, in completely burnable condition. In heavily sludged tanks, more than one application may be necessary.

Moreover, once the sludge in a system has been disposed of, the use of Magnus Clerex in considerably smaller concentration will prevent sludge from forming in the oil.

For further information circle No. 12

Gas Fired Homocarb

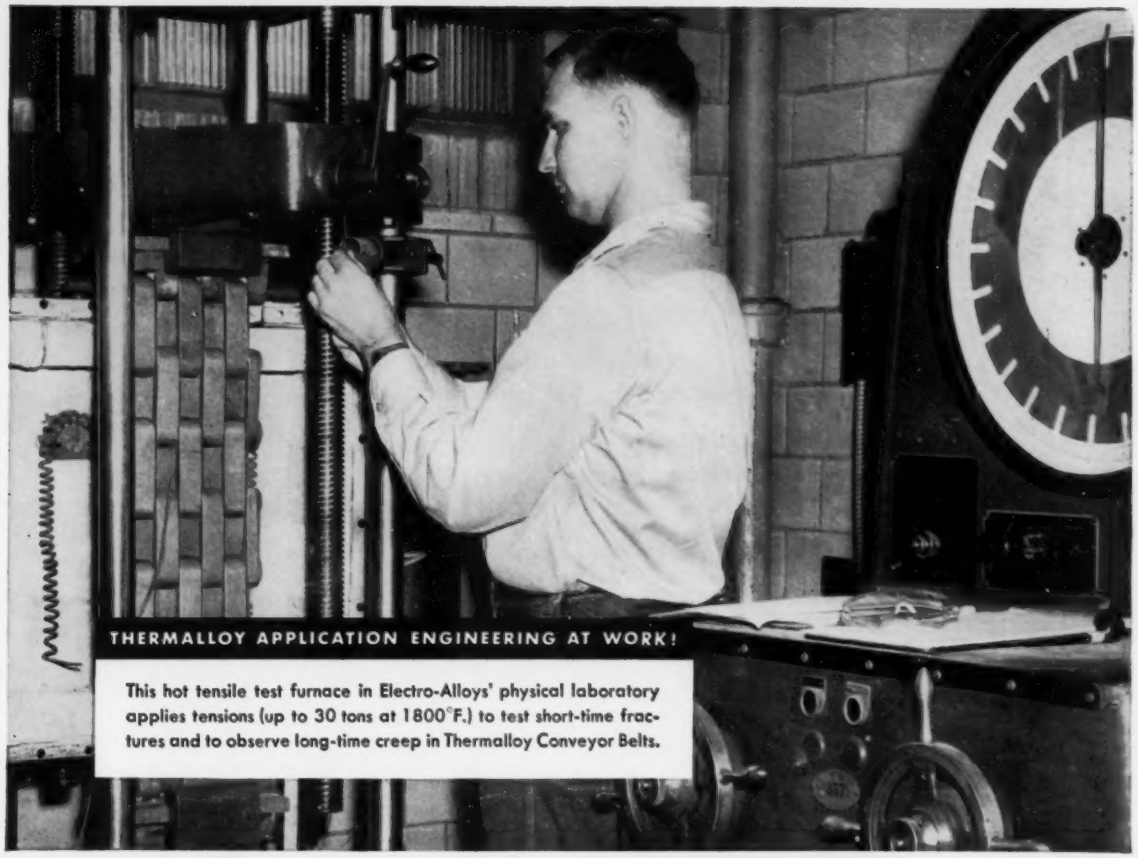
Leeds & Northrup Company has announced the extension of their Homocarb furnace line to include a gas-fired model, made in eight sizes, with work spaces from 15" x 18" to 25" x 48".

The furnaces are vertical, batch type units, identical with

Research In Heat Treating

Heat-treating furnaces used in research at Battelle Institute were a subject of interest to delegates to the recent (December 7 and 8) Titanium Symposium on Heat Treating and Alloying sponsored by the Metallurgical Advisory Committee on Titanium, Watertown

Arsenal. Battelle was the site of the two-day meeting. The group includes (left to right, front row): J. Kozol, Case Institute of Technology; E. L. Harmon, Case Institute of Technology; G. B. Wadsworth, Oak Ridge National Laboratories; W. O. Harms, Oak Ridge National Laboratories; W. J. Barth, E. I. Du Pont de Nemours; and tour guide, Edward Hodge, of the Battelle staff; (back row) A. L. Feild, E. I. Du Pont de Nemours; Marvin Parrish, Westinghouse Electric Corporation; Edwin Servis, Redstone Arsenal; J. A. Bryson, Cramet Corporation; and W. L. Meinhart, Crane Company.



THERMALLOY APPLICATION ENGINEERING AT WORK!

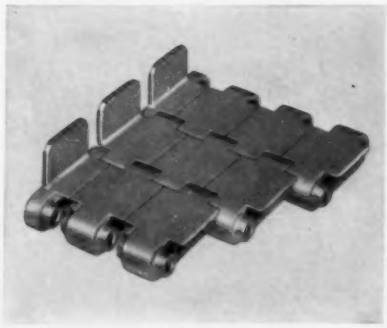
This hot tensile test furnace in Electro-Alloys' physical laboratory applies tensions (up to 30 tons at 1800°F.) to test short-time fractures and to observe long-time creep in Thermalloy Conveyor Belts.

A miniature furnace to test theories!

Service life of a heat-treating furnace conveyor belt may be affected by so many variables, i.e. uneven loading, misalignment, temperature differentials, etc., that proper design, highest quality and the right material are of utmost importance.

At Electro-Alloys, a staff of engineers and metallurgists are constantly studying these factors in the physical testing laboratory shown above. A hot tensile test furnace is continually in use subjecting Thermalloy* conveyor belts to various combinations of loading and temperature. In this way, design theories developed by our engineers are tested and highest possible quality standards are maintained to insure production of furnace conveyor belts that will be the ultimate in trouble-free operation.

Electro-Alloys also applies engineering and metallurgical know-how in the production of heat-resistant Thermalloy castings for other furnace parts such as sprockets, idlers, skid rails or rollers, crossbeams, wall boxes and radiant tube assemblies. For complete information, call our nearest representative or write for Thermalloy Conveyor Belt Bulletin T-241, Electro-Alloys Division, 6003 Taylor St., Elyria, Ohio.



To meet extra-severe operating conditions, a Thermalloy Heavy-Duty Conveyor Belt was developed. This partially assembled belt shows the short integral cast pins that eliminate "crank-shafting."

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

Elyria, Ohio

*Reg. U. S. Pat. Off.

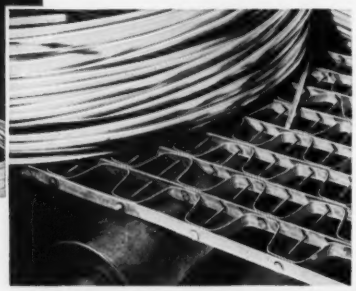
For further information circle No. 13

ROLOCK

HEAT AND CORROSION RESISTANT

FABRICATED ALLOYS

ONE PIECE "KING SIZE" SERPENTINE FURNACE GRID



now serves KAISER ALUMINUM

This, we believe, is the largest single piece grid of its type ever produced . . . and three of them are now in use at the Newark, Ohio Works of the Kaiser Aluminum & Chemical Corporation.

Despite the extreme length of the carrier (25 feet), there is freedom from warpage, due to the "Serpentine" and tie-rod design as shown in the insert photo above. Type 304 stainless steel strip with rolled edges prevents marring the coiled aluminum rod through annealing at 900° to 950°F. and water-spray quench at 60° to 80°F.

The first Rolock 8 ft. serpentine grids performance-wise were a big improvement over previous carriers, but the present 25 ft. "King Size" gives complete stability on the conveyor through the spray quench cycle and reduces multiple handling costs significantly. Grids are 6 ft. wide each, providing 150 sq. ft. of usable surface.

As in this instance, Rolock engineers will gladly cooperate with yours in designing engineered-to-the-job equipment for heat treating and finishing processes. We've solved many tough jobs . . . and are looking for more. Ask for Catalog B-8 (Heat Treating) or B-9 (Corrosion Resistant).

ROLOCK INC. • 1232 KINGS HIGHWAY, FAIRFIELD, CONN.

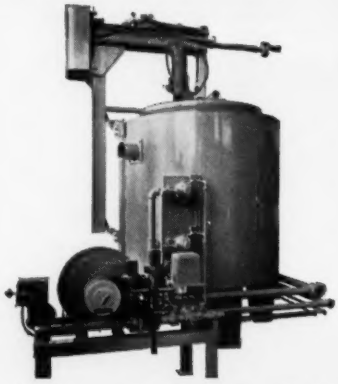
JOB-ENGINEERED for better work
Easier Operation, Lower Cost

10RL54B

For further information circle No. 14

News to Heat Treaters (Cont.)

other Homocarb furnaces except for method of firing. The burners are tangential to the combustion chamber; number of burners depends on furnace size. Burners are luminous-flame type, and the use of these burners reportedly produces a long flame which wraps around the furnace retort. The retort, it is said, thus becomes a single radiant tube, supplying a uniform wall of heat around the work chamber.



Equipment includes a "Safe-Start" burner control unit, with all gas and air valves, safety interlocks, blower and other accessories. Microcarb control is provided.

For further information circle No. 15

(Continued on page 38)

DEMPSEY FURNACES

GAS, OIL AND ELECTRIC
BATCH • CONTINUOUS

ATMOSPHERIC - RECIRCULATING - PUSHER — ROTARY HEARTH — CONVEYOR - RADIANT TUBE - POT CAR-BOTTOM - ALUMINUM REVERBS.

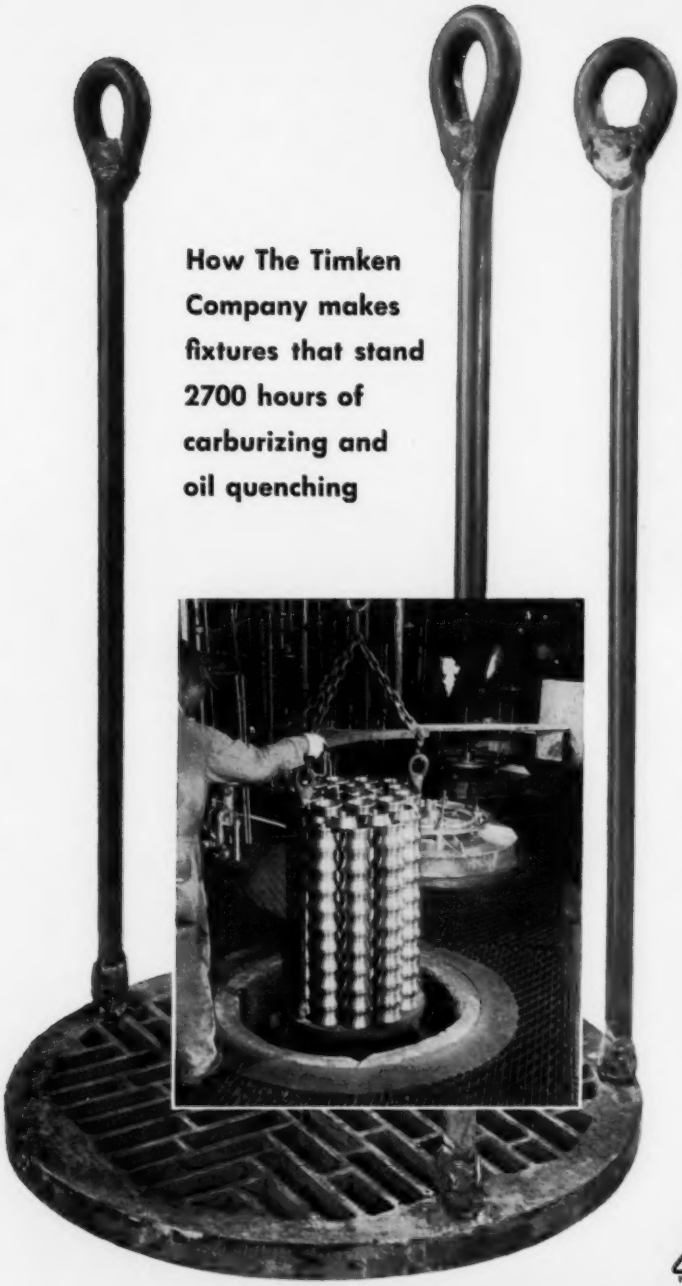
"Tailored by Dempsey"

DEMPSEY FURNACE

DEMPSEY INDUSTRIAL FURNACE CORP.
Springfield 1, Mass.

For further information circle No. 16

Service life doubled ...with Inconel



How The Timken Company makes fixtures that stand 2700 hours of carburizing and oil quenching

How long do *your* quenching fixtures last? And how much do they have to take? Perhaps the experience of The Timken Roller Bearing Company can help you save on replacement costs.

Roller bearing parts at The Timken Company are carburized in natural gas. This heat treatment is followed by an immediate oil quench.

During the whole process the parts are carried on a fixture consisting of three Inconel® eye-bolts welded to a grid. Formerly, under the corrosive conditions and severe thermal shock, eye-bolts only lasted an average of 1350 hours.

With Inconel, The Timken Company finds the service life of these eye-bolts has been doubled, and better. Some last up to 3700 hours.

This is possible because of Inconel's combination of valuable properties: its strength at high temperatures, its excellent resistance to oxidation and corrosion, and to thermal shock.

With these factors present, fabricated, well designed Inconel equipment is the logical choice for heat treating service followed by quenching. Of further importance, Inconel, despite its strength and toughness, can be readily formed. It is also easy to weld by any of the commonly used methods.

Try Inconel. You'll find, like The Timken Roller Bearing Company, that it is a high temperature alloy that gives long service under severe conditions. And for many suggestions on practical ways to make Inconel heat treating equipment write for our booklet, *Keep Operating Costs Down . . . When Temperatures Go Up.*

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

Inconel . . . *for long life at high temperatures*

HEAT TREATING ABSTRACTS

How to Control Hydrogen Embrittlement in 12 Cr Steels

By A. E. Kurkin

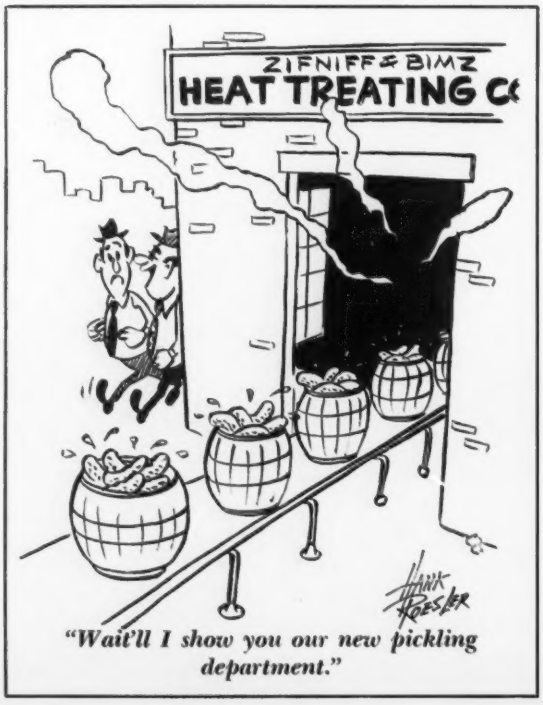
(*The Iron Age, December 9, 1954*)

This investigation is based on the use of both acid and basic solutions to cause the diffusion of hydrogen into 12% Cr steel. This permits a comparative analysis between the effect of hydrogen alone and the effect of hydrogen when associated with corrosion. A constant-rate bend test machine was used to gain comparative data on the following analysis steel: Carbon—.06 to .13; Chrome—11.50 to 13.00; Manganese—.25 to .80; Nickel, Aluminum Silicon, Tin—.05 max.; Sulfur—.03 max.; Moly—.20 max.

Tests indicated that harder materials are more susceptible to embrittlement. For example, material of Rc 45 hardness exhibited extreme brittleness while Rc 25 material showed almost none.

As might be expected, acid solutions proved considerably more harmful than basic solutions.

Tempering proved to be a solution to overcoming hydrogen embrittlement. In the steel tested, embrittlement was eliminated by tempering at or slightly above 1100° F. for two hours.



"Wait'll I show you our new pickling department."

Arc Weld Repairs on High Speed Tool Steel

By Kenneth Rose

(*Materials & Methods, September, 1954*)

A considerable loss was being experienced at the Buick Div., General Motors Corp., because of the high scrap loss on tools due to excessive wear, breakage or obsolescence. To reduce this loss, company metallurgists developed a method of arc welding with a high speed weld rod so that worn edges could be built-up or new sections added to old tools.

The process consists of using an inert gas-shielded arc with argon and using alternating current with superimposed high frequency for stabilization of the arc. The high frequency permits greater accuracy in depositing the weld without damaging adjacent surfaces. A tungsten electrode is used with an M36 analysis wire for filler. The wire composition is: Carbon—.80 to .90, Chrome—3.75 to 4.25, Vanadium—1.25 to 2.25, Moly—3.75 to 5.50, Tungsten—5.25 to 6.00, Cobalt—7.50 min., Manganese—0.20 to 0.40.

Parts to be welded are first ground where necessary and checked for cracks by Magnaflux. The part is then preheated to 500° F. and the weld deposited. After welding, parts are drawn at 1050° F. and reground to size.

The method has proved to be completely satisfactory and does not have the drawback encountered with repairs made by oxy-acetylene torch where excessive heat created difficulties.

Free Fall Quench Cuts Solution Heat Treating Costs

(*The Iron Age, May 13, 1954*)

The conventional method of handling aluminum aircraft parts at The Glenn L. Martin Co., Baltimore, Md., resulted in a number of disadvantages which were overcome by adopting a free fall technique for parts to be quenched in solution heat treatment. Using baskets to quench a number of parts at once it was found that the basket retained sufficient heat to effect the length of time required in a salt bath and that considerable excess salt was lost through carryout. Using the baskets it was also found that during the few seconds in which parts were subject to splashing, distortion occurred and was, in some cases, severe.

In the new free fall method, parts are suspended over the quench tank on a pipe by means of stainless steel wires. At any desired time the pipe is rotated and parts fall into the quench tank. They are then removed by raising a basket previously lowered into the tank.

With the new method it is reported that distortion has been decreased by as much as 90 per cent along with decreases in the amount of salt consumed and the time cycle required. ■ ■ ■

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Boiler Shop Using Bearcat Rivet-Sets Ups Average Run from 300 to 2470

The mechanical department of a large boiler shop had trouble driving more than 300 hot rivets, using standard rivet-sets. Once that mark had been reached, the sets would crack or spall. Sometimes recupping saved the day, but oftener than not the sets had to be replaced.

We were sure they could get longer runs with rivet-sets of Bearcat tool steel. The management gave Bearcat a trial, and put six sets to work after a heat-treatment cycle consisting of preheating at 1200F, air-quenching at 1750, and tempering at 550.

The results were even better than expected. The average run increased from 300 to 2470 before recupping was required. Not only that, but the recupping was accomplished without heat-treatment, which of course is a frequent source of trouble with rivet-sets of carbon tool steel.

Bearcat is an ideal tool steel for the manufacture of rivet-sets because of its superior shock-resistance. It is also well suited for uses where hot-work properties and easy machining are essential.

BEARCAT'S BIG FEATURES

1. Super shock-resistance
2. Deep-hardening . . . in air
3. Machines easily (Brinell 197 max)
4. Low distortion in heat-treatment
5. Good hot-work properties
6. Easily carburized for long wear

Typical Analysis

C	Mn	Si	Cr	Mo
0.50	0.70	0.25	3.25	1.40

In addition to being used for rivet-sets, Bearcat is ideal for such hot- and cold-shock applications as chisels, punches, hot headers and gripper dies. It has many other uses, too — master hobs, engraving dies, die-casting dies, and short-run dies used in cold-forming, blanking and bending.

You'll be well pleased with the service life obtained with Bearcat. We stock Bearcat in our mill depot. Or you can obtain a supply through your local Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Use Care When Hardening Hot-Work Tools

Although hot-work tools can be hardened to Rockwell C-56-60, there are hardly any applications where such hardness is beneficial. The majority of hot-work tools are used in a hardness range of C-41-44, or C-46-49. On new hot-work applications, a common mistake is to heat-treat to a hardness level which is too high for the application, with the result that rapid heat checking or breakage occurs.

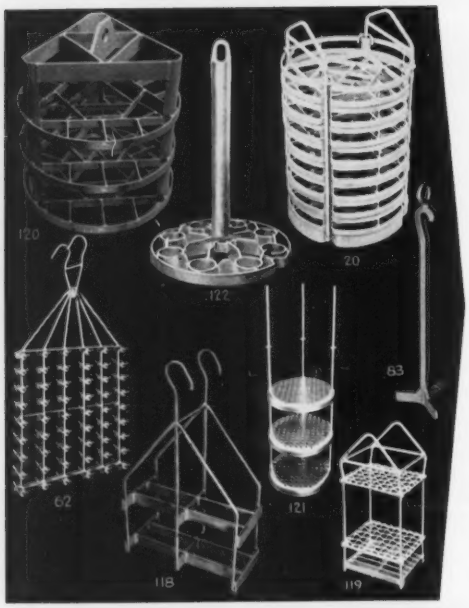
For example, put tools of our Hot Work 8 analysis to work at C-55 or higher, and chances are, they will fail prematurely. Yet these same tools, used at Rockwell C-52 or lower, will give outstanding service.

On every hot-work application the best hardness level must be determined by experience. There's always a compromise involved, as the highest hardness is best for wear-resistance, and the lowest hardness is more resistant to heat-checks. Our suggestion? To be sure of maximum service, don't overharden hot-work tools.

IT'S A-H5 FOR LONG PRODUCTION RUNS

This high-production die, made of A-H5, blanks and punches sheet steel of 0.180-in. thickness. A-H5 makes possible long production runs between grinds. It holds a durable cutting edge, and resists distortion in heat-treatment.

Too HOT to handle-



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For further information circle No. 19

News to Heat Treaters (Cont.)

Portable Brinell Tester For Non-Ferrous Alloys

A portable, light weight, hardness tester that is claimed to make accurate Brinell tests on non-ferrous alloys of all kinds has recently been developed by Andrew King, 67 E. Lancaster Avenue, Ardmore, Pennsylvania. The removable test head, an exclusive feature, makes it possible to test parts of any size or shape and the precision instrument can be used in any position, even upside down, with or without the base. The King Portable can be set to pop off at 62½ kg., 125 kg., 250 kg., 500 kg., 750 kg., and 1000 kg., the maximum load that can be applied.

For further information circle No. 20

I.H.E.A. Elects Officers

Horace Drever, President of Drever Company, Bethayres, Pa., (see cut) was elected President of the Industrial Heating Equipment Association, Inc., at their Annual Meeting held at the Sheraton-Cadillac Hotel, Detroit, January 24th and 25th. Elton Staples, Executive Vice-President of Hevi Duty Electric Co. was elected Vice-President.

Also elected to serve on the Board of Directors were W. E. Benninghoff, The Ohio Crankshaft Company; W. E. Holcroft, Holcroft Company and Elton Staples.

Bristol Expands

Construction work is nearing completion on an expansion of

the manufacturing plant of The Bristol Company, Waterbury, Conn. Heat treating facilities at the plant have also been recently increased to process a much larger volume of instrument parts and socket screws.

In addition to manufacturing facilities, an expansion in office space is being carried out, to provide added room for the engineering and research departments.

For further information circle No. 21

Portable Potentiometer

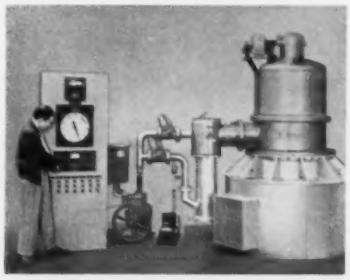
Pyrotest (Model 9A) is a portable potentiometer designed for checking and calibrating all types of industrial temperature instruments. Every instrument is calibrated for five ranges, which makes it possible for all types of thermocouples to be employed, i.e. chromel-alumel, iron constantan, platinum-13% Ph Pt, and platinum-10% Rh Pt. A millivolt range is included and special scales can be supplied for use with any suitable transducers.

Pyrotest is direct reading in terms of temperature. No charts, graphs or conversion tables need be used for accurate measurements. Complete cold junction compensation eliminates time consuming addition, subtraction, or other mathematical operations when using the instrument.

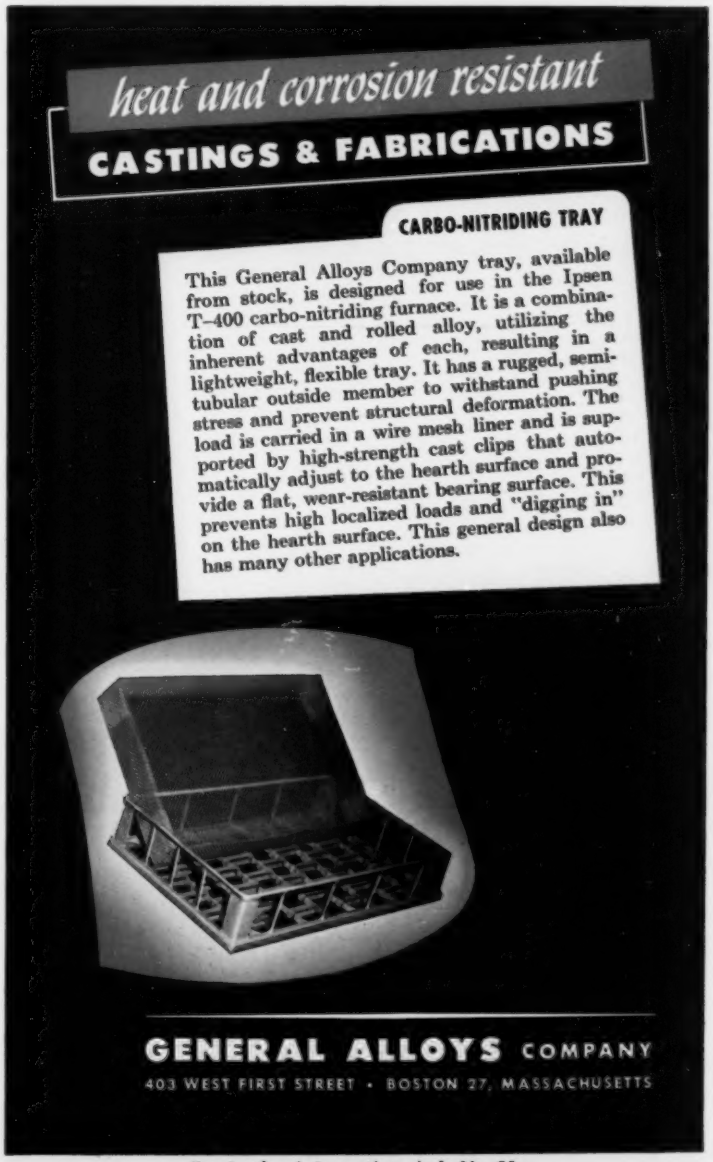
For further information circle No. 22

Annealing Titanium

The aircraft industry, working closely with engineers of the High Vacuum Equipment Corporation, Hingham, Massachu-



setts, has discovered that by annealing titanium parts in high vacuum annealing furnaces, the parts have greater strength and ductility to withstand elevated temperatures and severe stresses of supersonic speeds and therefore make flight safer. Hydrogen is removed and thereby greatly increases the strength and life of jet engine components. Hydrogen is present to some degree in all titanium, and by removing it and other unwanted gases during the annealing cycle, parts are made more ductile, have greater fatigue resistance, and longer life.


heat and corrosion resistant
CASTINGS & FABRICATIONS
CARBO-NITRIDING TRAY
This General Alloys Company tray, available from stock, is designed for use in the Ipsen T-400 carbo-nitriding furnace. It is a combination of cast and rolled alloy, utilizing the inherent advantages of each, resulting in a lightweight, flexible tray. It has a rugged, semi-tubular outside member to withstand pushing stress and prevent structural deformation. The load is carried in a wire mesh liner and is supported by high-strength cast clips that automatically adjust to the hearth surface and provide a flat, wear-resistant bearing surface. This prevents high localized loads and "digging in" on the hearth surface. This general design also has many other applications.
GENERAL ALLOYS COMPANY
403 WEST FIRST STREET • BOSTON 27, MASSACHUSETTS

For further information circle No. 23

"HI-VAC" Equipment Corporation has designed and built the majority of high vacuum annealing furnaces now in use to handle big sheets, castings, and long rods. (see cut) Horizontal or vertical designs are available to handle from several pounds to several tons, with operating at pressures of less than a micron, and temperatures up to 2000° F.

For further information circle No. 24

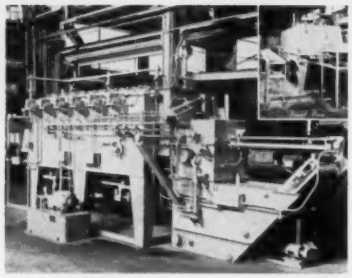
Radiant Tube Furnace

An unusual gas-fired vertical radiant tube hydraulic pusher production carbonitriding and gas carburizing furnace is now offered by Lindberg Engineering Company, Chicago, Illinois. It is designed to handle production loads of small parts requiring neutral hardening, carbonitriding, heavy and medium case gas carburizing and carbon restoration.

The cycle of operation is as follows. When the furnace is up to the desired temperature, the operator merely sets a cycle timer for desired pushing interval. When timer times out and rings a bell, he places a loaded basket on the front loading table, depresses a manual pushbutton and the pushing sequence starts. All following operations are automatic.

A flight conveyor carries the pieces from the quench and drops them into baskets. Work is never removed from the protective atmosphere once it enters the heating chamber until it emerges from the quench. This automatic sequence guarantees 100% consistency of case depth hour after hour, eliminating completely any possibility of operator error.

Heating is by means of 20 radiant tubes, 10 per zone, made of Inconel and suspended from the top plate. These light straight tubes give maximum heat transfer through the thin tube wall and minimum internal tube temperature for long life. All tubes are fired at the lower end and are



readily removeable from the top plate without the need for cooling the furnace or interrupting the operations. ■ ■ ■

For further information circle No. 26

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For further information circle No. 26

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138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000

Also available in pellet or liquid form.

FREE —Tempil° "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

Metal & Thermit Corp. 100 E. 42nd Street, New York 17, N. Y.

For further information circle No. 25

For Sale

1—R-S Gas-fired Hardening Furnace 2,400,000 BTU/hr. Controlled temperature to 1800°F. Heating zone 19' 0" long, 10' 0" wide, 4' 4" high.

1—R-S Gas-fired Drawing Furnace 2,000,000 BTU/hr. Controlled temperature 400°F. to 1300°F. Recirculating with 2 combustion chambers. Heating zone 30' 6" long, 10' 0" wide, 3' 2" high.

Both arranged for two zone temperature control. Complete with Brown recording and controlling potentiometers, conveyor chains, blowers, motor and other appurtenances.

John W. Bolton & Sons, Inc.
Lawrence, Massachusetts

LETTERS TO THE EDITOR

Dear Editor:

I have read with great interest the series of articles on "Cost Accounting in Heat Treating."

Your Institute has done a splendid job in placing emphasis on one of the most imoprtant subjects in any Industry today, and that is—Accurate Costing.

As to the technical aspects of the articles, the writers have clearly outlined the basis for a workable Unit Cost System.

A careful study and analysis of the cost and production centers, and a clear schedule for distribution of expenses, are the very basis for accurate cost data. This has been well described and illustrated in the first article.

The second article on establishment of departmental operating costs in each production center, has equal merit. The grouping and collection of all cost data in each production department is clearly illustrated and described.

In the last two articles dealing with the establishment and application of unit costs however, some of the accuracy of the first two chapters is being jeopardized by over-simplification and by using data based on experience rather than facts.

I refer, of course, to the establishment of labor requirements under normal operating conditions, and to the adjustment factor for labor efficiency.

For accurate unit costing, labor requirements should be established just as accurately as the actual operating cost data. This cannot be achieved by guesses, however experienced or intelligent they may be, but should be developed from production time data and time studies, collected over a period of time.

Similarly, the question of an adjustment factor to establish the efficiency of labor and operation, should be based on factual data and not approximation.

One more item requiring perhaps a little further explanation in your Cost Articles, is the question of how to adjust departmental costs with varying volumes of production. It would be helpful, if the Cost Committee could make some recommendations to show how the increases in burden percentage caused by lower production volumes during lean periods (over which the manufacturer has little control) can be averaged, to eliminate the need for high variations in heat treating costs.

R. S.
Management Engineer

Ed.—We expect to have a reply to this letter available for publication in the next issue.

Dear Sir:

Would it be possible for us to get another copy of the July-August issue or a reprint of the articles dealing with papers prepared by the Cost Accounting Committee of the Metal Treating Institute.

We are very interested in establishing a simplified cost system in our heat treating department and the methods outlined in your articles point out the least complicated system we have as yet studied.

Thanking you in advance for anything you can do in sending us these articles.

C. A. NELSON
N. A. Woodworth Co.
Detroit, Mich.

Ed.—Mr. Nelson's comment on the system closely matches our own thoughts; we think the committee has performed an outstanding service for the industry.

Gentlemen:

I obtained a copy of your May-June 1954 "Metal Treating" publication. The article "Cost Accounting for Heat Treating" is quite interesting to me, as I have had some beautiful arguments with our Cost Department.

I would be most appreciative if you would send me your next two issues.

DALE HENRY
Methods Department
Gar Wood Industries, Inc.
Findlay, Ohio

Ed.—Issues and reprints have been sent—hope they help out.

Dear Sir:

We have been watching with interest the progress of Titanium.

This would hardly be of any use to us until such time as it could be heat-treated to obtain considerably higher physical properties than those obtained at the present time.

We always enjoy reading your articles in the Metal Treating magazine, and would appreciate, at some time, your comments concerning the possibility of heat-treating Titanium; whether or not the possibility actually does exist, and what progress is being made on anything done so far.

GURDON LESLIE, Manager
Golf Shaft Department
True Temper Corp.
Geneva, Ohio

Ed.—Mr. Leslie will be interested in two articles on titanium in this issue. More to follow.

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MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

CLEANING ABRASIVE

A new bulletin describing Wheelabrator Steel Shot, a cast steel, heat treated, blast cleaning and peening abrasive, has been published by American Wheelabrator & Equipment Corp., of Indiana.

Included in this 8-page illustrated booklet is a discussion of the automatic process and quality control exercised in the company's new manufacturing plant. The plant is the largest of its kind in the world and is completely mechanized. Electric melting furnaces and automatically controlled heat treating equipment assure constant uniformity of product.

Other sections of the booklet include a tabular comparison of the characteristics of the various types of metallic abrasives. Also included is a discussion of the factors important to the economical and efficient consumption of abrasive.

For further information circle No. 28

AUTOMATIC CARBON POTENTIAL CONTROL

A new technical bulletin describing the "Autocarb" System for automatic carbon control of heat treat furnace atmospheres has just been issued by Surface Combustion Corporation, Toledo, Ohio. The bulletin describes the means by which the carbon potential of the furnace atmosphere may be controlled at the desired level for such processes as case carburizing, homogeneous carburizing, carbon restoration and clean hardening.

For further information circle No. 29

HEATING ELEMENTS

Norton Company, Worcester, Mass., has published an illustrated catalog on the characteristics and use of "Hot Rods," Crystolon heating elements made of self-bonded silicon carbide. The catalog includes complete technical data on electrical characteristics, service life, load, operating temperature and the effect of atmospheres. A section devoted to the use of "Hot Rods" covers mounting methods, power supply and connections along with helpful operating hints. Specifications for all available sizes and accessories are given.

For further information circle No. 30

TITANIUM

Rem-Cru Titanium Incorporated, Midland, Pennsylvania, are publishing regularly a technical bulletin entitled "Rem-Cru Titanium Review." It is described as being published to assist in the application and fabrication of titanium alloys. It contains a wealth of information as to the current uses and engineering properties of titanium alloys as well as suggestions and recommendations concerning possible applications.

For further information circle No. 31

QUENCHING OIL

Sun Quenching Oil No. 11, is described in a new Sunoco Technical Bulletin. This oil's high thermal stability and high boiling range are said to make it particularly suitable for quenching systems requiring a high flash-point. It has also been reported to be particularly suitable for bright quenching from controlled atmosphere furnaces.

For further information circle No. 32

CAST STAINLESS ALLOYS

The Alloy Casting Institute, technical association of high alloy foundries, has just published a set of data sheets covering the properties of all the more popular grades of alloys used for corrosion resistant (stainless steel) castings. Consisting of 13 individual data sheets describing each of the cast corrosion resistant alloy grades, the complete set, bound in a file folder, is available from the Alloy Casting Institute, Mineola, N.Y.

For further information circle No. 33

TEMPERATURE CONTROL

The Burling Instrument Company of Chatham, New Jersey, has issued Bulletin 104, the fourth in a new series describing their line of temperature controls.

This bulletin covers the Model D-18, primarily used for controlling temperatures up to 1800° F., where a wide and easily adjustable range is required.

The instrument described operates by the differential expansion of solids and uses no filled bulb. A snap-action switch, rated at 15 amp., 125-250 volts, 60 cycles, is actuated by the tube expansion through a lever.

For further information circle No. 34

PROTECTIVE ATMOSPHERES

A new bulletin describing the use of protective atmospheres to prevent deterioration of metals during various heat treating processes has been announced as available from the General Electric Company.

Designated as GEA-5907, the 12-page publication explains G.E.'s four basic types of gas-producing equipment which meet most protective atmosphere needs. Case histories illustrate the savings to be made in different types of jobs. Two tables are included, one a selection guide to help choose the correct protective atmosphere for each job and the other which explains the approximate compositions and costs of producing typical protective atmosphere gases.

For further information circle No. 35

MUFFLES AND RETORTS

On-the-job stories and pictures are featured in a 6-page, 2-color bulletin (T-239) describing Thermalloy high-heat-resistant muffles and retorts, available from the Electro-Alloys Division of American Brake Shoe Co., Elyria, Ohio. The bulletin describes how these high alloy castings are designed to resist abrasion, corrosive gases and excessive heat up to 2100° F. A breakdown of the Thermalloy group of high alloys into Alloy Casting Institute (A.C.I.) grades and alloy content is included. Free design and engineering services are also offered.

For further information circle No. 36

PROGRAM CONTROLLERS

Concise information about Speedomax program control systems, which are reported to offer complete flexibility in setting the rate of heating, length of the soak period, and the rate of cooling in batch-type heating processes, is available in a 2-page data sheet published by Leeds & Northrup Company. This data sheet, ND46 (4), lists the specific equipment required for each of five basic programming cycles, and the general equipment essential to a two-position or proportioning type of program control system.

For further information circle No. 37

HARDNESS TESTER

A four-page bulletin, describing the characteristics and use of the new Kentrall Hardness Tester, has been published by the Torsion Balance Company, Clifton, N.J. The bulletin describes the manner in which the instrument performs tests in both the superficial and regular ranges of Rockwell hardness testing. Illustrated features are the Kentrall Dial Gage, the Kentrall Load Selector, and the Kendent X Indenter.

For further information circle No. 38

POLISHING AND GRINDING

A 60-page "Production Digest" of authoritative papers on coated abrasive grinding and polishing techniques, has just been published by Behr-Manning Corporation, Troy, N. Y., to "help industry solve modern grinding and polishing problems and suggest new and practical methods." It constitutes the first known effort on the part of a coated abrasives manufacturer to compile a handbook of the art, and is assembled from 20 technical papers prepared by Behr-Manning methods engineers during the past two years for the leading periodicals of production engineering in both the metalworking and the wood-working fields.

For further information circle No. 39

COLOR BRINELL READINGS

The "Color-Glance" Brinell Hardness Tester, a new development of Steel City Testing Machines, Inc., is illustrated on a 4-color catalog sheet, No. KE 1154, recently published. The three colored lights of the testing machine, which indicate the relative hardness of the parts being tested on a production basis, are each shown in natural color on the front of this 8½" x 11" bulletin. Also incorporated are complete specifications and a discussion of the tester's new features which make possible high speed production testing and complete automatic operation when required.

For further information circle No. 40

Index To Advertisers

Advertiser	Page
American Brake Shoe Company Electro-Alloys Division	33
American Cyanamid Company Metal Chemicals Section	Inside Back Cover
American Gas Furnace Co.	29
Armour & Company Ammonia Division	19
Bethlehem Steel Company	37
Crucible Steel Company	7
Dempsey Industrial Furnace Co.	34
Drever Company	13
General Alloys Co.	39
General Manufacturing Co.	40
Holden Company, The A. F.	Inside Front Cover
Houghton & Co., E. F.	9
International Nickel Co.	35
Metal & Thermit Corporation	40
Metal Treating Institute	22-23
Misco Fabricators, Inc.	38
Park Chemical Co.	15
Pressed Steel Company, The	Outside Back Cover
Rolled Alloys, Inc.	17
Rolock, Inc.	34
Stanwood Corp.	27
Sun Oil Company	31

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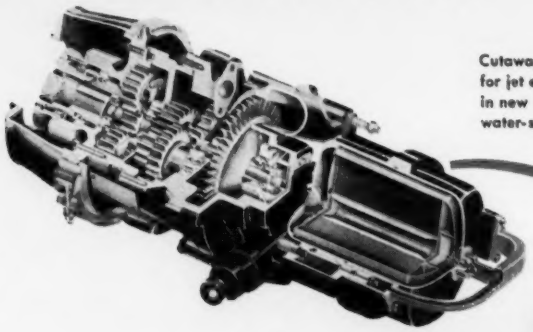
for jet engine starter clutch

with new AEROCARB® carburizing compounds



Cutaway of a General Electric gas turbine starter for jet engines shows clutch components they carburize in new high-speed, high-temperature, water-soluble AEROCARB Carburizing Compounds.

Sleek new Martin B-57 jet light bomber has starters housed in streamlined pods seen at each engine air intake opening.

Clutch mechanisms for gas turbine starters must deliver tremendous power to bring jet engines to starting speed. To get the toughness and strength they need, General Electric Company's Aircraft Accessory Turbine Dept. at Lynn, Massachusetts, carburizes these parts in Cyanamid's new, high-speed, high-temperature AEROCARB S and (as the bath replenisher) AEROCARB R Carburizing Compounds.

Chief feature of these new AEROCARB compounds is deep and rapid penetration with minimum distortion. Many of the parts require 0.060" case depth, which G-E achieves at 1650-1750° F in just 8-9 hours with AEROCARB water-soluble salts. They use the same salt bath for their short time, shallow case work. Drag-out from this bath is low; wash-off is fast, easy, and complete with warm water.

These remarkable new AEROCARB carburizing compounds can solve your case hardening problems — give you high quality results in less time and at lower cost. The attached coupon is for your convenience.

Cyanamid's heat treating compounds include:		*Other products for metal processing include:*	
AEROCASE®	Carburizing Compounds	AEROMET®	Metallurgical Additive
AEROCARB®	Case Hardening Compounds	Metallic Stearates	
AEROHEAT®	Heat Treating Compounds	Surface Active Agents	
		Acids and other Heavy Chemicals	

®Trade-mark

MT1-55

AMERICAN Cyanamid COMPANY

METAL CHEMICALS SECTION

30 Rockefeller Plaza, New York 20, N. Y.

☐ Send technical data sheet on AEROCARB S
☐ Have technical representative call

Name_____ Position_____

Company_____

Address_____

City_____ State_____

In Canada: North American Cyanamid Limited, Toronto and Montreal

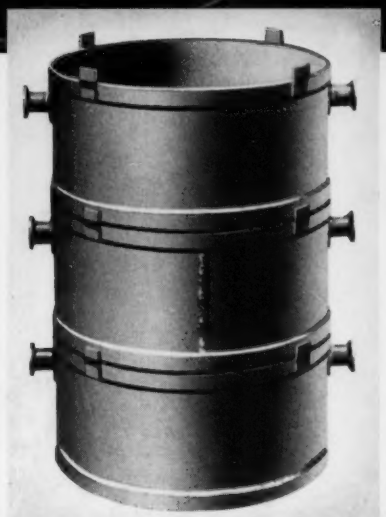
For further information circle No. 41

PSC *Light-Weight* RETORTS FOR ATMOSPHERE FURNACES

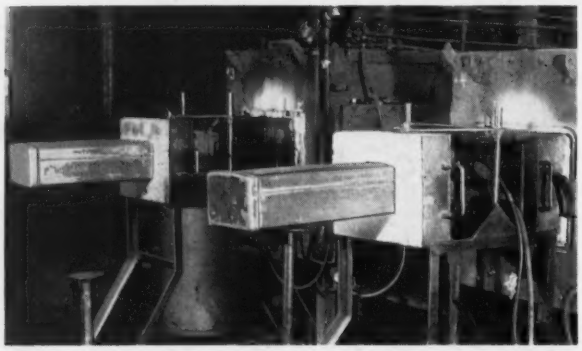
Shorten Cycle. Cut Fuel Cost. Up Capacity.

Retort for carburizing long work; suspended to prevent distortion. Any size.

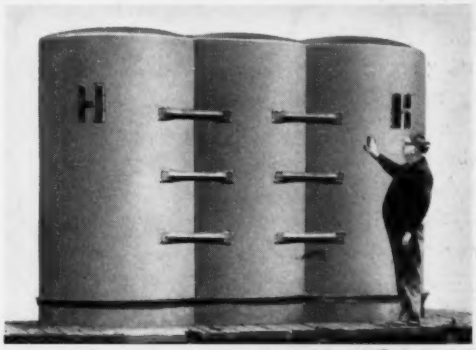
Retort has fabricated grid-type bottom. Light weight saves handling and heat-up time.



Retort for small lots of different parts -- one of many special-purpose PSC heat-treat units.



Above, retorts for 2150°F. At right, light-weight hoods; handle easily. PSC fabricates complete list of ferrous and non-ferrous metals, alloys.



For complete line of heat-treat carriers, **CATALOG 52.**

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THE PRESSED STEEL COMPANY

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Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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